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ACADEMIC JOURNAL

May Issue

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Comparative Analysis of Emissions of Electric, Petrol and Hybrid cars By Arav Agarwal

Abstract

The automotive sector is now a substantial source of greenhouse gas emissions, which have an adverse effect on the environment and the world at large. This research paper presents a comparative analysis of the emissions created by petrol cars, electric cars, and hybrid cars, and how these emissions can be reduced. It also looks into the legislation that is being developed by governments to combat climate change and cut CO2 emissions. The study emphasizes the huge environmental impact that gasoline-powered cars have and demonstrates how converting to electric or hybrid vehicles can have a positive influence on the world. The study also looks at how decarbonizing the grid, reusing batteries, utilizing better materials to create engines, and employing electric vehicles can all cut CO2 emissions.
Overall, the paper emphasizes how quickly greenhouse gas emissions must be reduced and climate change must be stopped. According to the study's findings, switching to electric and hybrid vehicles, along with the use of renewable energy sources and battery recycling, can assist to dramatically lower CO2 emissions and lessen the effects of climate change.

Introduction

The transportation industry is a substantial contributor to the world greenhouse gas emissions, accounting for 14% of total emissions. (IPCC, 2018). One of the ways to reduce these emissions is by transitioning to electric, hybrid, and other alternative fuel vehicles. These vehicles have the potential to significantly reduce emissions from the transportation sector, particularly if they are powered by clean energy sources.

Electric vehicles (EVs) are powered solely by electricity and do not produce any emissions while in operation. On the other hand, hybrid vehicles have an internal combustion engine and an electric motor that enable them to run on both electricity and fuel. Hybrid vehicles can reduce emissions by using the electric motor during low power demands, such as when driving at low speeds or in stop-and-go traffic. (US Department of Energy)

Electric and hybrid vehicles have seen a rise in popularity in recent years, as governments and consumers seek to reduce their carbon footprint and dependence on fossil fuels. However this interest for electric and hybrid cars is only present in European markets. In Norway, for example, in 2020, 75% of cars were electric. Whereas in India, only 0.2% of cars are electric and 99.8% are internal combustion engine cars, i.e., not electric or hybrid. (International Energy Agency)

This research paper aims to conduct a comparative analysis of the emissions of electric, petrol, and hybrid vehicles. The study will take into account the emissions linked to the manufacture and use of these vehicles, as well as the impact of different sources on the emissions

of these vehicles. The study will also examine factors such as emissions produced in engine manufacturing and battery life. This paper also discusses the Paris Agreement and the impact it has had on the environment. Additionally, it discusses the environmental effects of internal combustion engine vehicles and viable alternatives.

The results will provide a comprehensive understanding of the emissions of electric, petrol, and hybrid vehicles and will help identify opportunities for reducing emissions from the transportation sector.

Methodology

This study compares emissions from petrol, electric, and hybrid vehicles. This paper will analyse the emissions produced and their sources, the emissions produced during battery and engine manufacturing, and whether there are any alternate technologies that offer the same benefits as electric, gasoline, or hybrid vehicles without the drawbacks.

Discussion–Emissions

Different Sources of emissions in the production and operation of vehicles
In this part of study we discuss emission from 3 different types of vehicles: 1) Petrol vehicles(ICE) 2) Electric vehicles(EV) 3) And lastly Plug in hybrids (PHEV).

When it comes to petrol emissions there are 2 main sources. Tailpipe & manufacturing emissions. Tailpipe emissions are mentioned later in the paper. When it comes to manufacturing emissions this consists of the emissions created in the transport of materials, emissions involved in the powering of the factory etc.

We are aware that an average electric car releases half as much greenhouse gases as an average European passenger car. (Hall and The International council of clean transport, 2018)Even the current market's most efficient internal combustion engine vehicle performs around 27% worse over the course of its lifetime than an electric vehicle powered by standard European power. (research group MOBI and Messagie) Despite this there are still many ways electric cars produce emissions. An area where a lot of emissions are produced is battery manufacturing. According to a study that happened in 2017 battery manufacturing produces 56 kg CO2e/kWh (Hall and The International council of clean transport 3). This amount is lower than the results found by many other studies. For example one study by Authors Hanjiro Ambrose and Alissa Kendal (Ambrose and Kendal)stated that assuming a manufacturing grid similar to ones in east asia the amount produced could be anywhere between 194 to 494 kg CO2e/kWh. This is primarily because of where the battery manufacturing occurs. If a 30 kWh battery is made in the European Union, its GHG emissions are lower. According to that report, BEVs will emit fewer life-cycle emissions when driven in any European nation than an equivalent diesel vehicle. (European Federation for Transport and Environment, 2017)

Another study mentioned in the same paper stated that similar batteries when produced in China gave emissions along the range of 96-127 kg CO2e/kWh (Hao et al., n.d.) using the

Chinese grid to produce batteries. uncovers significant variations across battery chemistries. American-made batteries produce 65% fewer GHGs.

The reason for these huge differences has to do with their grid. If the primary source of electricity in a country comes from fossil fuels, AKA a carbonised grid. This adds on to the emissions produced in the manufacturing of these cars. Therefore countries where a large portion of their electricity comes from fossil fuels, like china where 80% of energy comes from fossil fuels, will have higher emissions than those with a smaller portion of energy from fossil fuels, like norway where 98% of energy comes from renewable sources of energy.

The efficiency of the electric drivetrain and the gasoline engine, the driving environment, and the source of the electricity needed to charge the batteries are only a few of the variables that will affect how much emissions are created by PHEVs. In general, PHEVs are designed to be more efficient than traditional petrol-powered cars, and can produce lower emissions under certain driving conditions.

When operating in electric mode, PHEVs produce no emissions at the point of use, as the electricity used to power the vehicle is typically generated from a power plant. (US department of Energy, n.d.) But if the electricity required to recharge the batteries is produced using fossil fuels like coal or natural gas,, it can result in significant emissions of greenhouse gasses, including carbon dioxide (CO2) (Hall, 2018). On the other hand, the emissions related to charging the batteries can be greatly reduced or even eliminated if the electricity is produced using renewable resources, such solar or wind energy.

In gasoline mode, PHEVs emit carbon dioxide (CO2), nitrogen oxides (NOx), and particulate matter (PM), which are identical to those of conventional gasoline-powered vehicles. (Ehrenberger & Konrad, 2022) The emissions produced in petrol mode will depend on the efficiency of the petrol engine and the driving conditions.

Different Gasses in the Emission of Vehicles

Gasses of several varieties are released by gasoline-powered automobiles. They release hydrofluorocarbons (HFCs), nitrous oxide (N2O), and methane (CH4) from leaking air conditioners. In 2023, the US Environmental Protection AgencyIn addition, there are emissions of carbon dioxide (CO2) from the tailpipe. Although these gases produce fewer emissions than CO2, they still have a significant impact since they have a higher global warming potential (GWP) than CO2.

An average passenger vehicle produces 4.6 metric tonnes of carbon dioxide each year(Environmental Protection Agency, 2023). This is based on the assumption that the typical gasoline car on the road today gets roughly 22.0 miles per gallon and travels about 11,500 miles annually. 8,887 grams of carbon dioxide are produced for every gallon of fuel used. (EPA)

A typical American passenger car with an internal combustion engine generates 0.016 grams of methane per mile, or 0.0000353 pounds of methane gas each mile, according to the EPA, while averaging 23.4 miles per gallon in fuel efficiency. (Environmental Protection Agency, 2023). For passenger cars made in 2009 or after, the EPA estimates nitrous oxide

emissions from ICE vehicles burning regular petrol at 0.0036 grams per mile or 7.94 X 10-6 pounds per mile. (Environmental Protection Agency, 2023)

Electric vehicles (EVs) don't emit any exhaust. A fuel cell car running on hydrogen will only emit water vapor. (US department of energy AFDC (FCEV's), n.d.). Carbon dioxide (CO_2), nitrogen oxides (NOx), and particulate matter (PM) are all emissions from PHEVs operating in gasoline mode.

Policy on Emissions–Paris Climate Agreement

Because of the imminent threat posed by climate change, countries have established a variety of regulations to limit their nation's emissions of greenhouse gases. The countries which need to rarity the highest percentage of GHG emissions are China(20%), USA(17.8%), Russia(7.53%), India(4.1%) and Japan(3.79%) respectively.

As a result, the UN established the Paris Climate Agreement. The Paris Climate Agreement, also known as the United Nations Framework Convention on Climate Change (UNFCCC), was signed in 2015 by more than 190 countries in an effort to reduce greenhouse gas emissions and mitigate the effects of climate change. n.d. (United Nations Climate Change). The agreement establishes a framework for countries to act in order to keep global warming well below 2 degrees Celsius and to explore steps to keep it to 1.5 degrees Celsius.

Several objectives and targets for lowering greenhouse gas emissions are outlined in the Paris Climate Agreement, including:
- Increasing nations' capacity to adapt to the effects of climate change
- Making financial flows adhere to a course that will result in minimal greenhouse gas emissions and development that is climate-resilient
- Facilitating the transition to renewable energy sources
- Enhancing the removal of greenhouse gases from the atmosphere

According to the Paris climate agreement by 2030, at least 20% of all road transport vehicles must be powered by electricity, although currently electric vehicles only have a 1% global market share (International Energy Agency, 2021). According to IEA modelling, sales of electric cars, such as fuel cell, plug-in hybrid, and battery-electric vehicles, must account for 35% of global sales by 2030.

Although many people are disappointed with the Paris climate agreement as according to the New York times prior to this week's United Nations climate meeting, data from the independent research group Climate Action Tracker reveals that none of the world's four largest emitters—China, United States, European Union, and India—have reduced their emissions sufficiently to meet the Paris Agreement's goals. (Popovich, 2022)

India's present policies and activities, according to the Climate Action Tracker, are "insufficient" in comparison to its fair share contribution. This is due to the fact that India's second NDC (Nationally Determined Contribution) strengthened its targets on paper, but will not drive real world emission reductions beyond its current level of climate action. Significant improvements are needed for India's climate policies and actions to be in line with the 1.5°C temperature target in 2030. Global warming would exceed 2°C and potentially even approach 3°C if other countries adopted India's strategy.

According to the Climate Action Tracker, if current policies continue, India's emissions in 2030 will be between 4.1 and 4.3 GtCO2e (Climate Action Tracker, 2022). This estimate exceeds our prediction from the previous year by 219–234 MtCO2e. This significant change in carbon emissions is mostly attributable to the fact that the Indian economy has begun to recover from its COVID-19 lows, which has led to a surge in energy demand, particularly in the industrial sector. (Climate Action Tracker, 2022)

China's economy was originally shut down by the COVID-19 epidemic in 2020, with carbon-intensive industries like chemicals, iron and steel, food and beverage production, cement and concrete, and forest goods suffering the most (Climate Action Tracker, 2022). However, with an upswing in heavy industry and construction activities, the economy quickly rebounded.

The nation expects an additional 30 GW of coal-fired power plant installation by year's end, bringing the total to 1140 GW, and an additional 180 GW by 2030 (from levels in 2020), which will result in an increase in power consumption in China of 5% to 6% in 2022 (CEC, 2021).

In fact the interesting thing is that the most powerful and biggest countries in the world are not able to meet it while smaller, more underdeveloped countries are countries such as Nigeria, Ethiopia, Morocco, Gambia and Kenya as well as Costa Rica and Nepal.

Indian Policies to encourage adoption of electric cars

In order to encourage the use of electric cars (EVs) and the growth of the electric vehicle industry, the Indian government has created a variety of laws and incentives. Some examples of these policies include:

1. FAME India (Faster Adoption and Manufacturing of (Hybrid &) Electric Vehicles in India): This program offers financial assistance for the purchase and usage of EVs, including electric two-wheelers, electric three-wheelers, and electric buses. The program also supports R&D for EVs and associated parts, as well as the development of charging infrastructure and technologies.

2. National Electric Mobility Mission Plan (NEMMP) 2020: This plan aims to accelerate the deployment of electric vehicles in India and make EVs a viable alternative to petrol-powered vehicles. The plan includes targets for the number of EVs to be deployed in different sectors, as well as incentives for the purchase and use of EVs.

3. GST (Goods and Services Tax) rate reduction: The GST rate for EVs has been reduced to 5%, compared to 28% for petrol-powered vehicles, in order to make EVs more affordable for consumers.
4. Income tax benefits: The Indian government has introduced income tax benefits for individuals and businesses that purchase EVs, in order to encourage the adoption of these vehicles.
5. State-level incentives: Some states in India have implemented their own policies and incentives to promote the adoption of EVs, including subsidies and tax breaks for EV buyers and support for charging infrastructure development.

Overall, the Indian government has taken a number of steps to promote the adoption of EVs and encourage the development of the electric vehicle industry in the country. These efforts are part of a broader push to reduce greenhouse gas emissions and address the challenges of climate change. A very good example of this is the Norwegian government, which offers tax benefits for electric vehicles and a 25% levy on cars that run on fossil fuels (Norsk elbilforening, n.d.). Because of this 86% of cars are electric in norway. (Carlier, 2022)

Impact of Petrol Cars on Climate Change

As mentioned before petrol cars have many ways in which they impact climate change. Including tailpipe and manufacturing emissions. Which include carbon dioxide (CO_2), nitrogen oxides (NOx), and particulate matter (PM).These emissions contribute to the warming of the Earth's atmosphere and are a major driver of climate change.

The Intergovernmental Panel on Climate Change (IPCC) claims that road transportation is a considerable contributor to the transportation sector's overall greenhouse gas emissions. In actuality, after the energy industry, road transportation is the second largest global producer of CO_2 emissions.

Electric Vehicles as Substitute for Petrol Cars

Electric vehicles (EVs) are increasingly being seen as a substitute for traditional petrol-powered cars, as they offer a number of advantages over these vehicles in terms of their environmental impact and operating costs. Some of the key advantages of EVs including Zero emissions at point of use, Reduced operating costs, Better Performance and Range Increase over the years.

Zero Emissions at the Point of Use : EVs produce zero emissions at the point of use, as they are powered solely by electricity. This makes them a cleaner and more sustainable alternative to petrol-powered cars (Environmental Protection Agency, 2023). One type of tech they use for this is called Regenerative Braking. EVs often employ regenerative braking systems that capture and store energy during braking, increasing energy efficiency and reducing wear on traditional friction brakes. (Tires Plus, 2022)

Reduced operational expenses since electric vehicles (EVs) often have lower operating costs than gasoline-powered vehicles because they need less maintenance and have cheaper fuel.

In addition, many governments offer financial incentives and tax breaks for the purchase and use of EVs(Like Norway), which can further reduce their operating costs. A reason why they have reduced costs is because they have fewer moving parts compared to internal combustion engine (ICE) vehicles, resulting in lower maintenance requirements and costs. Their Performance is also exceptional, EVs can offer quick acceleration and smooth, quiet operation, as well as a smooth and comfortable ride. (Wallbox, n.d.)

Range: With several models now capable of traveling more than 300 miles on a single charge, the range of EVs has dramatically increased in recent years. It is crucial to remember that the size of the battery, the weather outdoors, and the age of the vehicle are just a few of the factors that will affect the range of an EV.

Overall, EVs offer a number of advantages over traditional petrol-powered cars, including reduced emissions and operating costs, quiet operation, and improved performance and range. Because of these aspects, EVs are becoming a more appealing solution for customers and legislators who want to cut greenhouse gas emissions and combat the effects of climate change.

Although Ev's do have the disadvantage of emissions produced in battery manufacturing, luckily studies show that debt related to life cycle emissions from battery manufacture is swiftly repaid. The increased emissions produced during the manufacturing process of an electric vehicle are offset after only two years of driving compared to an average conventional vehicle (Hall, 2018); The repayment duration is shortened to around 1.5 years if the car is powered by renewable energy. The electricity utilized in their manufacturing accounts for around half of the pollutants that batteries produce. According to estimates, roughly 25% of an electric car's lifetime emissions are attributable to battery production, which is comparable to the output of the typical internal combustion engine vehicle. However, there has been a 10-fold variation in recent estimates of emissions from battery manufacture, underscoring the need for more research in this area.

Hybrid cars as a substitute

Hybrid vehicles are a type of vehicle that combines an electric drivetrain with a traditional petrol-powered engine. These vehicles can switch between electric and petrol modes depending on the driving conditions, and are designed to be more efficient than traditional petrol-powered cars.

Hybrid vehicles are often seen as a substitute for traditional petrol-powered cars, as they offer many of the same benefits as electric vehicles (EVs) in terms of fuel efficiency and emissions. However, it's crucial to remember that hybrid cars cannot fully replace electric vehicles, as they still rely on a traditional petrol-powered engine and do produce emissions. They may not be a direct substitute of Ev's but they do serve as an alternative for people who want to do the environmentally right thing but may have very few charging stations in their country. (Acko, 2023)

Some of the key advantages of hybrid vehicles compared to traditional petrol-powered cars include:

- Improved fuel efficiency: Generally speaking, hybrid automobiles are more fuel efficient than conventional gasoline-powered vehicles, as they can switch between electric and petrol modes depending on the driving conditions. This can result in significant fuel savings for drivers. (Tyagi, 2023)
- Reduced emissions: Hybrid vehicles produce lower emissions than traditional petrol-powered cars, as they rely on the electric drivetrain for a portion of their power. The efficiency of the petrol engine as well as the source of the electricity needed to charge the batteries will both affect how much pollution hybrid vehicles emit. (Ghosh, n.d.)
- Reduced operating costs: Due to their increased fuel efficiency and lowered maintenance needs, hybrid vehicles often have lower operating expenses than conventional petrol-powered cars. (Tyagi, 2023)

Overall, hybrid vehicles offer many of the same advantages as EVs in terms of fuel efficiency and emissions, and can be an attractive alternative for consumers looking to reduce their environmental impact and operating costs. However, it is important to consider the full lifecycle emissions of hybrid vehicles, including both direct emissions from the vehicle during operation and indirect emissions from the production of the vehicle.

Battery Life

These emissions are significant even if the environmental advantages of electric cars throughout their whole lives surpass those of battery manufacture.

Manufacturing of batteries depends on countries' grids, in different countries different amounts of carbon emissions are produced.

As mentioned before a study that happened in 2017 says that battery manufacturing produces 56 kg CO_2e/kWh. Which is lower than what other studies state. This is primarily because of where the battery manufacturing occurs. (Romare & Dahllöf, 2017) This is Because the 30 kWh battery is made in the European Union, its GHG emissions are lower. This is because the grid is mostly decarbonized in the European union. According to a 2017 research by Romare & Dahllöf, manufacturing energy accounts for at least 50% of the emissions produced by batteries over their entire life cycle, with battery production emissions ranging from 150 to 200 kg CO_2e/kWh. This assumes that the battery was made in Asia.(Romare & Dahllöf, 2017)

There are many ways to mitigate the risk :
- Grid decarbonization : Batteries would be cleaner if more renewable energy was used and more efficient power plants were built, as the electricity required in the manufacturing process accounts for nearly half of the emissions related to battery manufacture. By 2030, it's projected that in most markets where fossil fuel burning is still prevalent, the carbon intensity of electricity will have decreased by more than 30%. 6 By 2030, emissions from battery manufacture will have decreased by roughly 17% as a result of the global power grids being decarbonized by an average of about 30%. The greenhouse gas emissions

linked to the manufacturing of metals like aluminum will also be decreased by lowering grid emissions. (Hall, 2018)

- Recycling batteries : With the growth of the market for electric vehicles, battery recycling will become simpler. The materials used in the production of batteries are responsible for around half of the greenhouse gas emissions, and recycled resources often have a smaller carbon footprint than equivalent raw materials. Recycling aluminum reduces greenhouse gas emissions by around 95% in comparison to producing aluminum from natural sources. (Hall, 2018)

Engine Manufacturing

The emissions created during the manufacturing of electric vehicle (EV) engines will depend on a variety of factors, including the materials used, the energy source used to power the manufacturing process, and the efficiency of the manufacturing process itself.

Generally, the production of EV engines is associated with the emission of greenhouse gasses, including carbon dioxide (CO_2), together with additional air pollutants. These emissions may be produced throughout the manufacturing process when fossil fuels are employed, as well as during the extraction, shipping, and processing of the raw materials used to make EV engines.

The emissions created during the production of EV engines are typically significantly higher than the emissions produced by the vehicles during their lifetime.intensive battery manufacturing means that building a new EV can produce around 80% more emissions than building a comparable gas-powered car (MIT climate Portal, 2022). However, it is important to consider the full lifecycle emissions of EVs, including both the emissions from manufacturing and the emissions produced during the operation of the vehicle. This can give us a more thorough grasp of how EVs affect the environment.

To reduce the emissions associated with the production of EV engines, it is important to adopt more efficient manufacturing processes and use renewable energy sources to power the manufacturing process. In addition, using materials with a lower environmental impact and recycling materials can also help to reduce the emissions associated with the production of EV engines.

Sustainable Alternative solutions

There are a number of sustainable alternative solutions that can be used to power electric vehicles (EVs), including:

Renewable energy: One of the most sustainable alternatives to fossil fuels is renewable energy. This includes renewable energy sources like solar, wind, and hydroelectric power that don't emit greenhouse gases. By using renewable energy to power EVs, it is possible to significantly reduce the environmental impact of transportation.

Biofuels: Biofuels are fuels that are produced from renewable plant materials or waste products. Some common biofuels include ethanol, biodiesel, and biogas. Biofuels can be used to power EVs, and have the advantage of being renewable and having a lower carbon footprint than

fossil fuels.

Hydrogen fuel cells: Using hydrogen gas as a fuel, Electricity is produced by a chemical reaction in hydrogen fuel cells. Hydrogen fuel cells are an environmentally friendly and long-lasting replacement for fossil fuels because the only waste product of this process is water. It is crucial to remember that greenhouse gases are released during the generation of hydrogen fuel, and that many locations lack the infrastructure needed for hydrogen fuel cell vehicles.

Overall, there are a number of sustainable alternative solutions that can be used to power EVs, including renewable energy, biofuels, and hydrogen fuel cells. By adopting these alternatives, it is possible to significantly reduce the environmental impact of transportation and transition to a future that is more sustainable.

Conclusion

This study's objective was to compare the greenhouse gas emissions created by Petrol cars, Electric cars and hybrids. The study also then looks at the factors that lead to emissions in Electric cars and hybrids and the possible ways of reducing it. In today's world this topic holds a lot of importance as climate change has become a very prevalent issue. Majority of all developed countries are far away from meeting the Paris agreement,for example the UK, USA, India and the EU. According to the scientific american most of these countries are roughly 7 years off the target, and reducing CO2 emissions which could have substantial negative effects on the planet. Due to this it is important that people make the switch from petrol to electric or hybrid vehicles as it can help reduce CO2 emissions significantly. Another alternative to buying an electric car could just be to stop using private transport and rely more on public transport like metro, buses etc. Most people are under the impression that electric vehicles don't have any emission and that purchasing them will in turn produce no CO2. This study looks into what emissions are produced by vehicles from different sources and how electric cars and hybrids can be used as a substitute. It has also looked into how we can make changes to engineer manufacturing and battery manufacturing in order to reduce CO2 emissions such as grid decarbonisation and reusing batteries. The paper also discusses how purchasing an electric vehicle is actually inefficient if it is not utilised for at least two years because it takes that many years to make up for emissions emitted during manufacturing.

There are few common criticisms of electric cars, often the criticism is that the Battery lifespan is very short. This is because lithium-ion battery packs lose a little portion of their overall capacity with each charge cycle. These incremental reductions in the battery pack's maximum capacity gradually reduce an EV's overall driving range (McAleer, 2022). The cost of replacing the battery can be significant and so it is not efficient to buy an electric car, but what this argument fails to take into account is how battery technology has advanced significantly over the years. Over time technology will adapt and batteries will become more efficient and till then a way to reduce the cost of batteries could be to recycle batteries.In this field a way to make batteries more efficient would be by researching more into battery chemistry, improving electrode materials and enhancing thermal management. All the other common criticisms have to

do with how there are limited charging stations and limited options, but fail to take into account that as more people start buying electric cars this infrastructure will also develop. In America and Countries part of the European union this is already happening thanks to companies like Tesla and Efacec.

The study's findings make it abundantly evident that electric automobiles emit much fewer emissions than gasoline-powered vehicles. This can be accomplished by promoting the use of renewable energy to power these vehicles and by making investments in the construction of new infrastructure, such as charging stations. To make electric vehicles more accessible and effective, e top priority should be given to the research and development of new battery technology. By switching to electric or hybrid vehicles, we can drastically lower our carbon footprint and contribute to the fight against climate change.

Works Cited

Acko. (2023, May 17). *What is a Hybrid Car? Hybrid Vs. Electric Cars - Advantages*. Acko.
  Retrieved August 12, 2023, from
  https://www.acko.com/car-guide/what-is-hybrid-car-hybrid-vs-electric-cars-advantages/

Carlier, M. (2022, September 1). *Norway: PHEV and BEV market share*. Statista. Retrieved July
  21, 2023, from
  https://www.statista.com/statistics/1029909/market-share-of-electric-cars-in-norway/

Climate Action Tracker. (2022, November 3). *India - Assessment - 03/11/2022*. Climate Action
  Tracker. Retrieved July 21, 2023, from
  https://climateactiontracker.org/countries/india/2022-11-03/

Ehrenberger, S.I., & Konrad, M. (2022, August 30). ✍️. YouTube. Retrieved July 21, 2023, from
  https://www.sciencedirect.com/science/article/abs/pii/S1352231020303460

Environmental Protection Agency. (2023, May 30). *Tailpipe Greenhouse Gas Emissions from a
  Typical Passenger Vehicle | US EPA*. Environmental Protection Agency. Retrieved June
  24, 2023, from
  http://www.epa.gov/greenvehicles/greenhouse-gas-emissions-typical-passenger-vehicle

European Federation for Transport and Environment. (2017, October 26). *Electric vehicle life
  cycle analysis and raw material availability*. Transport & Environment. Retrieved June
  24, 2023, from
  https://www.transportenvironment.org/discover/electric-vehicle-life-cycle-analysis-and-ra
  w-material-availability/

Ghosh, A. (n.d.). *Advantages and Disadvantages of Using Hybrid Cars*. Conserve Energy
  Future. Retrieved August 12, 2023, from
  https://www.conserve-energy-future.com/advantages-and-disadvantages-of-hybrid-cars.p
  hp

Hall, D. (2018, Febuary). *Effects of battery manufacturing on electric vehicle life-cycle
  greenhouse gas emissions*. International Council on Clean Transportation. Retrieved June
  24, 2023, from
  https://theicct.org/sites/default/files/publications/EV-life-cycle-GHG_ICCT-Briefing_090
  22018_vF.pdf

Hao, H., Jiang, S., Liu, Z., & Zhao, F. (2017). GHG Emissions from the Production of
  Lithium-Ion Batteries for Electric Vehicles in China. *Sustainability*, *9*(4), 504. Retrieved
  June 24, 2023, from https://www.mdpi.com/2071-1050/9/4/504

International Energy Agency. (2021, April 20). *Global EV Outlook 2021: Accelerating
  Ambitions despite the Pandemic*. Dot.net. Retrieved August 12, 2023, from
  https://iea.blob.core.windows.net/assets/ed5f4484-f556-4110-8c5c-4ede8bcba637/Global
  EVOutlook2021.pdf

International Energy Agency. (2023, July 11). *Electric vehicles - IEA*. International Energy
  Agency. Retrieved July 21, 2023, from
  https://www.iea.org/energy-system/transport/electric-vehicles

McAleer, B. (2022, October 26). *How Long Do Electric Car Batteries Last?* Car and Driver. Retrieved June 24, 2023, from https://www.caranddriver.com/research/a31875141/electric-car-battery-life/

MIT climate Portal. (2022, October 13). *Are electric vehicles definitely better for the climate than gas-powered cars?* MIT Climate Portal. Retrieved August 12, 2023, from https://climate.mit.edu/ask-mit/are-electric-vehicles-definitely-better-climate-gas-powered-cars

Norsk elbilforening. (n.d.). *Norwegian EV policy*. Norsk elbilforening. Retrieved July 21, 2023, from https://elbil.no/english/norwegian-ev-policy/

Popovich, N. (2022, November 8). *The World Is Falling Short of Its Climate Goals. Four Big Emitters Show Why.* The New York Times. Retrieved July 21, 2023, from https://www.nytimes.com/interactive/2022/11/08/climate/cop27-emissions-country-compare.html

Romare, M., & Dahllöf, L. (2022, August 30). ✍. YouTube. Retrieved July 21, 2023, from http://www.ivl.se/download/18.5922281715bdaebede9559/1496046218976/C243+The+life+cycle+energy+consumption+and+CO2+emissions+from+lithium+ion+batteries+.pdf

Tires Plus. (2022, March 18). *Regenerative Braking: Advantages, Disadvantages, & How It Works*. Tires Plus. Retrieved August 12, 2023, from https://www.tiresplus.com/blog/brakes/what-is-regenerative-braking-in-electric-vehicles/

Tyagi, S. (2023, March 29). *What Are Hybrid Cars: Types, Functions, Benefits*. Spinny. Retrieved August 12, 2023, from https://www.spinny.com/blog/index.php/what-are-hybrid-cars-types-functions-benefits/

United Nations Climate Change. (n.d.). *The Paris Agreement*. UNFCCC. Retrieved July 21, 2023, from https://unfccc.int/process-and-meetings/the-paris-agreement

US department of Energy. (n.d.). *Alternative Fuels Data Center: Emissions from Electric Vehicles*. Alternative Fuels Data Center. Retrieved July 21, 2023, from https://afdc.energy.gov/vehicles/electric_emissions.html

US department of energy AFDC (FCEV's). (n.d.). *Alternative Fuels Data Center: Fuel Cell Electric Vehicles*. Alternative Fuels Data Center. Retrieved July 21, 2023, from https://afdc.energy.gov/vehicles/fuel_cell.html

US Environment Protection Agency. (2023, April 13). *Overview of Greenhouse Gases | US EPA*. Environmental Protection Agency. Retrieved July 21, 2023, from https://www.epa.gov/ghgemissions/overview-greenhouse-gases

Wallbox. (n.d.). *How Do Electric Vehicles Compare To Gas Cars? | Wallbox*. wallbox blog. Retrieved August 12, 2023, from https://blog.wallbox.com/en-usa/how-do-evs-compare-to-gas-cars/

The Soft Power of the World Cup By Kushal Durga

Abstract

This paper seeks to determine the relationship between soft power and the global sporting event of the World Cup. To answer this question, this paper analyzes the effects of two previous World Cups on the soft power of the host nation. The 2018 and 2022 World Cups were chosen to be analyzed. Through research, we have found that while a World Cup can improve a nation's familiarity with foreigners, it does little to influence the attitudes of the host nation. Using these findings, host nations could strive to find ways to maximize soft power gain through sporting events.

Introduction

The World Cup is one of the most watched events in human history. It is a time when the sports world collides with culture. This massive event is a chance for competing countries to advertise themselves on the world stage. Countries spend up to $300 billion to host this prestigious event and take part in its rewards. The question that this paper proposes is: What insights may we gain from prior World Cups that might affect future competitions?

This paper will choose to look at the World Cup through the lens of soft power. This paper will be divided into three sections. The first section will concern the definition of soft power. The second section will explore the two case studies of the 2018 and 2022 World Cups. The third will focus on what insights can be gained from both studies and how they can be applied to the 2026 World Cup.

Hard Debates on Soft Power

Soft power is a term that has been the topic of much academic discourse ever since it was originally coined by Joseph Nye, who describes it as "the ability to achieve goals through attraction rather than coercion." (Gomichon, 2013, p. 1) There are three main pillars of national soft power: culture, political values, and foreign policies. (SoftPower30, 2023) Cultural soft power emanates from the attractiveness of a nation's cultural resources, whether that be movies, food, art, or sporting events. Political soft power comes from the appeal of a country's principles of governance; for example, in the case of the United States, freedom and democracy. Soft power in regard to foreign policy is based on the presence of a nation in international affairs, such as how they interact with other countries. Being friendly while interacting with other nations creates a different image than being combative. A combination of these three pillars creates a pull toward the state, or, in other words, soft power (Masterclass, 2023).

The buildup of soft power is a long and costly process. This growth requires consistency and cohesion in the state's statecraft. To generate soft power, a feeling of sincerity and commitment must be built up over time. (Thompson, 2020). Any deviation from the state's

built-up actions will lead to a loss of soft power. Actions that follow a nation's previous policies will gain a sense of continuity and attraction.

Soft power is more useful when power is scattered rather than concentrated from a domestic perspective. Despotic governments have less need to consider the opinions and perceptions of their domestic populace. If a regime is despotic, it would be easy to prevent the spread of external soft power from other countries through the blocking of art, film, and literature. This allows easier control of a populace through soft power. While democratic governments have elected officials, which requires power to come from the populace, this means that the populace's perceptions and opinions matter, forcing the need for domestic soft power. (World101, 2023).

There are many critiques of Joseph Nye's definition of soft power within academia, such as the critique of Aldo Matteuci (n.d.). The critique rests on redundancy, stating soft power had already been defined and explored many years before under the name of image. He believes that soft power adds no meaningful insight to the effects of national or personal image. Matteuci (n.d.) used the example of Napoleon in 1812, who already understood the power of an image and used it to create an air of invincibility. He uses this example to prove that the power of soft power has been understood and known for a long period of time through the idea of image.

This critique is itself flawed. First, even though the facets of soft power have always existed, Nye's term provides a conceptual basis for analysis. Secondly, soft power and image are two different concepts. Image is a facet of soft power, not the whole. Soft power is not just the image or brand of a state but also the attractive pull from culture and soft power resources, which do not have to be state-backed. To go back to the Napoleonic example, his image of invincibility was solely state-backed; it did not involve private sources of soft power. This idea of a hard power image is addressed in Nye's 2005 book, S*oft Power: The Means to Success in World Politics* (2005). Napoleon's image is built on hard military power and victory in warfare, not on soft power. An example of a soft power image is Sweden's image of eco-friendliness. An image can stem from either soft or hard power. This critique misrepresents soft power as an image, showing a misunderstanding of the term.

Another significant critique of the validity of soft power comes from neorealists such as Nial Fergurson (2003). He argues that soft power is ineffective and specifically says,

"The trouble with soft power is that it's, well, soft. All over the Islamic world, there are kids who enjoy (or would like to enjoy) bottles of Coke, Big Macs, CDs by Britney Spears, and DVDs starring Tom Cruise. Do any of these things make them love America more? Strangely not." (p.28)

His criticism focuses on how soft power cannot truly influence others and is therefore an ineffective form of power. Interacting with foreign cultures does not necessarily mean that those cultures have any effect on someone. (Ferguson, 2003).

The neorealist critique has been addressed by Joseph Nye (2006). Someone consuming American-based products does not mean that America or its culture have any influence over

them. Just like other sources of power, soft power resources require context to be useful. For example, a powerful close-range naval fleet is quite weak against a landlocked country such as Mongolia, while against a country such as the UK, a fleet would be very effective. The example Nye uses is of a large tank army generating hard power while at war against a flat country like Bahrain, while that same army would be ineffective in a jungle such as Vietnam. (Nye, 2006). Thus, Nye posits that Ferguson's critique conflates soft power resources and behavior.

Nye conceptualizes soft power as an attractive pull that can lead to cooperation. This concept has stood up to many different criticisms and has proven reliable. Additionally, almost all soft power indexes use Joseph Nye's definition, and these indexes will be used within the next section, such as the Soft Power 30 and Brand Finance. It is for these reasons that the rest of this paper will use Nye's concept of soft power.

Intro to Case Studies

One of the three pillars or sources of soft power is culture. A way to spread culture and therefore increase a state's soft power resources is through major sporting events such as the FIFA World Cup. The World Cup is a massive opportunity to spread culture through art, travel, advertising, and a spotlight on the host nations' values and culture. The World Cup has a massive impact on states' soft power resources and on a state's soft power itself. (Mahmood, 2023) This section will present the background for the two most recent world cups, the Qatar FIFA World Cup 2022 and the Russia FIFA World Cup 2018, as case studies.

These two competitions were chosen because they were the most recent World Cups, so the insight that will be gained from their analysis will be more useful in future cases. These studies will be used to gain future insights into the effects of the World Cup on soft power.

Russia's World Cup Gamble

Russia started to consider and use soft power as a strategy in 2004 at the behest of Vladimir Putin. This began with the establishment of the Institute for Democracy and Cooperation, with stations in New York and Paris (Ageeva, 2021). They also created Sputnik News, an influential state-backed news program. At this time, Russia was focused on building soft power in nearby countries, especially the Commonwealth of Independent States (CIS). The 2008 Georgian invasion significantly impeded much of the progress in the work. (Karabeshkin, 2015) This issue was also exacerbated by the foreign media blocks, allowing President Mikhail Saakashvili's perspective to go unchallenged in foreign markets (Dobbs 2008).

Following this failure, the Kremlin refocused on the implementation of soft power through governmental agencies. Russia took many steps, including the creation of the Russian International Affairs Council, which is a state-backed diplomatic think tank (Putin, 2015). Notably, Russia hosted the 2014 Winter Olympics in an attempt to increase international prestige and rouse a feeling of nationalism. This served as an event to advertise the side of Russia the state wanted to present, one of solidarity and strength (McPhee, 2014). This soft power strategy was once again hampered by the annexation of Crimea in 2014.

Due to the annexation of Crimea, Russia tried to build its soft power arsenal again through the use of a multitude of tools, such as the Russia Today network. Using Soft Power 30, a reputable index listing the top 30 nations in terms of soft power, we can determine the effect of these early soft power plays. In the soft power category, Russia went from being below the top 30 soft power nations to rising to 28th in 2018. (softpower30, 2019). This strategy bore fruit in Russia's hosting of the 2017 FIFA Confederation Cup. Shaun Walker (2017) of the Guardian noted that the reason for hosting the event was to act as a prelude to the World Cup and dispel the perception of hooliganism, corruption, labor rights, and human rights. Indeed, Russia's winning bid for the Confederation Cup, based on its soft power strategy, served as a springboard for Moscow's successful bid for the 2018 World Cup.

Russia's World Cup was used to win hearts and minds on a domestic and international scale. Putin remarked to a reporter, "Many foreigners have learned about our culture and our cities, and they have met our openhearted people, and millions of people—not thousands but millions—have changed their views on Russia. It is an achievement—a big achievement (Hodge 2018).

This concept is refuted in the article Politicization of a *Contested Mega Event: The 2018 FIFA World Cup on Twitter.* This article sampled data from Twitter, finding tweets related to a pro-Russia sentiment or sentiments surrounding the suppression of LGBTQ+ members within the country. It was concluded that the World Cup had no massive impact on any uptick in pro-Russian sentiment but did have an impact on pro-LGBTQ+ tweets. However, the article did go on to explain that this uptick in LGBTQ+ sentiment was largely overshadowed by the competition itself. This implies that the world did not actually benefit Russia in any meaningful way (Meier, 2021).

Meier's point of view is backed by the soft power index Softpower30, which moved from 26th to 28th in the global soft power index from 2017 to 2018 (Softpower30, 2017, 2018). The index puts responsibility on many different actions related to foreign policy decisions, including increasing antagonism in the west. Despite Putin's claims of the importance of the World Cup, it may not have been enough to keep Russia in the good graces of a large section of the global community.

Qatar's Soft Power Evolution

Qatar is a smaller state with a diminutive population and a non-substantial military force. Qatar has used both its economic power in the form of natural gas and intelligent foreign policy decisions, including soft power, to remain relevant and independent within the highly turbulent Gulf region. (Nayeroğlu, 2021)

Qatar's use of soft power is varied, and it uses all three pillars of soft power effectively. We will first discuss its foreign policy decisions. Since the country's inception in 1971, it has allied with Saudi Arabia as a shield against Iran. Then, in the early 2000s, it allied again with the United States to provide a countermeasure against Saudi influence. The turning point in this

strategy of dependence was the Arab Spring. (Kabalan, 2020) The Arab Spring was a large wave of protest and civil war across the Arab world, starting in Tunisia in 2011. (editors of Encyclopedia Britannica, 2023) After this massive event, Qatar took on a more proactive role in foreign politics, such as with the political backing of the Morsi Egyptian government.

Another massive soft power tool Qatar has at its disposal is the Al-Jazeera network. It is a massive news channel owned by Qatar and broadcast throughout the Middle East. Forbes ranked it as the second-largest news channel in the Middle East. (Forbes, 2014) The channel has become a powerful soft power resource and a major part of Qatar's foreign diplomacy. Al-Jeerza has a pattern of supporting post-Arab Spring states and is used to spread the politics of Qatar. (Telhami, 2016)

Another major pillar of soft power is political values. Qatar fulfills this pillar through the creation of human rights initiatives. This started with the reorganization of the Qatari National Human Rights Commission, which was given further autonomy and funding. Furthermore, many seminars and assemblies were held to promote workers rights'. This allowed the Qatari government to use a pro-worker rights brand to help silence potential criticism. (Nayeroğlu, 2021)

This combination of the three major pillars of soft power resources has given Qatar a significant soft power pull, as it was ranked 26th in the world prior to the 2022 World Cup, according to Brand Finance's 2022 Soft Power Index. (BrandFiance, 2022) This is an impressive feat for such a small nation, which has the 143rd largest population of any country. After the World Cup, Qatar was ranked 24th in the world. Brand Finance stated that the staging of the World Cup had a massive effect on this historic rise in soft power. (BrandFiance, 2023)

Qatar had many plans for the World Cup. Many speculated that the purpose of the competition was to increase the image of being a mediator in the Middle East, and a massive international tournament would play such a role. (Ibrahim, 2023) The World Cup also uncovered many human rights issues in Qatar. (Ronald, 2022) Not many studies have been conducted throughout the world on the perception of the global audience. A study in Britain found that prior to the World Cup, 67 percent of Brits viewed Qatar negatively, and that number rose to 72 percent. While 9 percent of people viewed Qatar positively, that number rose to 12 percent. This shows that, at least in Britain, the World Cup did not shift views of Qatar but mostly polarized and advertised Qatar to more people.

Insights

We have delved into two prior World Cups. Each competition is unique and has had different effects on the world at large and the host nation. This section seeks to apply the insight we have previously gained from these previous World Cups and apply it to the upcoming 2026 World Cup and its effects on soft power.

To begin, the major criticisms of both previous World Cups were workers' rights issues. Media outlets such as CNN (Riley, 2017) reported that at least 17 workers had died in connection to the 2018 FIFA Russia World Cup, with other sites saying as many as 21 (Watch, 2018).

Workers rights issues were as numerous, if not more so, in Qatar. With sources ranging from 400–500 migrant worker deaths in relation to the construction of the World Cup, Qatar has also had a history of worker rights abuses prior to the competition. (Mngqosini, 2022) A poll was conducted to understand how the general public from 15 countries felt about Qatar's worker rights abuses. Reuslts included 73 percent of people wanting FIFA to use a percentage of revenue to pay workers and their families, and 67 percent want FIFA to make an official statement regarding the issue (Amnesty, 2022).

A large detractor of the World Cup in Qatar and its overall goal of presenting a positive image of Qatar was its multitude of worker rights abuses leading up to the competition, as mentioned prior. In the planning of the next World Cup, it will be imperative to not allow these abuses to happen in the construction of infrastructure and refurbishing stadiums to maximize soft power gain. There is reason to believe that this scenario will most likely play out due to the fact that no new stadiums will be built for the competition (Ravenscroft, 2022). Additionally, the tourism infrastructure of the United States, Canada, and Mexico is much stronger when combined with the infrastructure of Qatar and even Russia. The host nations can hold up to 146 million visitors per year, compared to the previous hosts of Russia and Qatar, which had only 24 million and 14 million, respectively (World Population Review, 2019).

Another consideration is the overall soft power of the World Cup and how to maximize that increase. Russia's world failed to increase its soft power the following year, and it actually dropped. Similar things can be seen with Qatar, with more people recognizing the country but no significant increases in positive feelings regarding the nation. It can be deduced from these 2 examples that while the World Cup has the power to popularize a country, it cannot override its global image. Future honesty will need to keep this fact in mind when planning future soft power moves.

Soft power takes a long amount of time to accrue. It also requires a certain consistency and cohesion, as explained previously. It is for the season that believes that the World Cup should be used as a step in a soft power journey, not a standalone event. Future hosts, including the United States, Mexico, and Canada, should use the World Cup as an example of their soft power image. This tactic should be employed to fully utilize the soft power gained from the World Cup.

Conclusion

While the economic effects of the World Cup cannot be overstated, its effects on soft power are much more subtle. Through literary analysis, we have defined and explored the term soft power. This paper has looked at the various criticisms of the term from various perspectives and why many of these criticisms fall short. The paper has studied the effects of two prior World Cup's and how they fit into a much larger soft power strategy. Finally, this paper sought to find insights from these competitions and how we might apply these insights for future installments of the tournament. Through the use of better working conditions and understanding the World

Cup not as a standalone competition but as a step in a soft power strategy, countries can hope to increase their standing on a global scale.

Works Cited

The 2018 FIFA World Cup in Russia: Sponsorship and human rights (no date) Center for Sport and Human Rights Available at: https://www.sporthumanrights.org/library/the-2018-fifa-world-cup-in-russia-sponsorship-and-human-rights/#:~:text=The%202018%20FIFA%20World%20Cup%20in%20Russia%20will,adverse%20impacts%20directly%20associated%20with%20the%20World%20Cup. (Accessed: August 25 August 2023).

Arab Center Washington DC (2023) Actors, structures and Qatari foreign policy, Arab Center Washington DC. Available at: https://arabcenterdc.org/resource/actors-structures-and-qatari-foreign-policy/ (Accessed: 16 August 2023).

Arab spring (2023) Encyclopædia Britannica. Available at: https://www.britannica.com/event/Arab-Spring (Accessed: 16 August 2023).

Brandirectory (no date) Brand Values, Profiles & Global Rankings. Available at: https://brandirectory.com/softpower/2022/report (Accessed: 16 August 2023).

Elias, N. (1982) The civilizing process. Oxford: Blackwell.

FIFA World Cup 2026 continues focus on human rights due diligence (no date) Inside Sports Law | Global law firm | Norton Rose Fulbright. Available at: https://www.nortonrosefulbright.com/de-de/inside-sports-law/blog/2023/07/fifa-world-cup-2026-continues-focus-on-human-rights-due-diligence (Accessed: 25 August 2023).

Gomichon, M. (2014) Joseph Nye on Soft Power. Available at: https://www.e-ir.info/2013/03/08/joseph-nye-on-soft-power/ (Accessed: 02 August 2023)

Hodge, N. (2018, December 31). *The World Cup was the only thing that mattered to Putin*. CNN. https://www.cnn.com/2018/12/31/europe/putin-2018-world-cup-analysis-intl/index.html

Huseynov, V. (2018) The nexus of neoclassical realism and soft power, the case of the west – Russia geopolitical rivalries in the 'Common Neighbourhood', Startseite. Available at: https://ediss.uni-goettingen.de/handle/11858/00-1735-0000-002E-E529-1?locale-attribute=en (Accessed: 02 August 2023).

Ibrahim, M. (2023) Menatalla Ibrahim, Doha News | Qatar. Available at: https://dohanews.co/author/menatalla-ibrahim/ (Accessed: 25 August 2023).

Jr., J.S.N. (2006) Think again: Soft power, Foreign Policy. Available at: https://foreignpolicy.com/2006/02/23/think-again-soft-power/ (Accessed: 10 August 2023).

Kozin, D. (2023) What will Russia do with its Giant World Cup stadiums?, The Moscow Times. Available at: https://www.themoscowtimes.com/2018/07/19/what-will-russia-do-with-giant-world-cup-stadiums-a62246#google_vignette (Accessed: 25 August 2023).

Lai, H. and Lu, Y. (2013) China's soft power and international relations. London: Routledge, Taylor & Francis Group.

Mahmood, S. (2023) How Qatar's Soft Power won the World Cup, The National Interest. Available at:
https://nationalinterest.org/feature/how-qatar%E2%80%99s-soft-power-won-world-cup-206087 (Accessed: 25 August 2023).

Meier, H. E., Mutz, M., Glathe, J., Jetzke, M., & Hölzen, M. (2021). Politicization of a Contested Mega Event: The 2018 FIFA World Cup on Twitter. Communication & Sport, 9(5), 785-810. https://doi.org/10.1177/2167479519892579

Mngqosini, S. (2022) Qatar World Cup chief says between 400 and 500 migrant workers have died in projects connected to the tournament, CNN. Available at:
https://www.cnn.com/2022/11/29/football/qatar-world-cup-migrant-worker-deaths-spt-intl/index. html#:~:text=World%20Cup%20chief%20Hassan%20Al-Thawadi%20said%20that%20between, greater%20figure%20than%20Qatari%20officials%20have%20cited%20previously. (Accessed: 25 August 2023).

Null (2014) Top TV channels online in the Arab world, Forbes ME. Available at:
https://www.forbesmiddleeast.com/list/top-tv-channels-online-in-the-arab-world/ (Accessed: 16 August 2023).

Nye, J.S. (2012) Soft power: The means to success in world politics. New Delhi: Knowledge World.

Næss, H.E. (2023) A figurational approach to soft power and sport events. the case of the FIFA World Cup Qatar 2022 TM, Frontiers. Available at:
https://www.frontiersin.org/articles/10.3389/fspor.2023.1142878/full#F1 (Accessed: 02 August 2023).

Qatar: Global survey shows overwhelming demand for FIFA to compensate World Cup migrant workers (2023) Amnesty International. Available at:
https://www.amnesty.org/en/latest/news/2022/09/qatar-global-survey-shows-overwhelming-dema nd-for-fifa-to-compensate-world-cup-migrant-workers/ (Accessed: 25 August 2023).

Qatar Soft Power: From rising to the crisis - researchgate | find and ... Available at:
https://www.researchgate.net/publication/354222935_Qatar_Soft_Power_From_Rising_to_the_ Crisis (Accessed: 17 August 2023).

Repnikova, M. et al. (2022) Soft power: The means to success in world politics, Foreign Affairs. Available at:
https://www.foreignaffairs.com/reviews/capsule-review/2004-05-01/soft-power-means-success-world-politics (Accessed: 02 August 2023).

The rise and fall of Russia's soft power (no date) Russia in Global Affairs. Available at:
https://eng.globalaffairs.ru/articles/rise-fall-russias-soft-power/ (Accessed: 10 August 2023).

Ronald, I. (2022) How has holding a World Cup changed the way the world sees Qatar?, CNN. Available at:
https://www.cnn.com/2022/12/17/football/qatar-legacy-world-cup-2022-spt-intl/index.html (Accessed: 16 August 2023)

Russia passes Confederations Cup test but hosts need a team to rally behind | Shaun Walker (2017) The Guardian. Available at: https://www.theguardian.com/football/2017/jul/01/russia-confederations-cup-world-cup-dress-rehearsal (Accessed: 16 August 2023).

The Russia-georgia conflict: What happened and future implications for US foreign policy (no date) Wilson Center. Available at: https://www.wilsoncenter.org/event/the-russia-georgia-conflict-what-happened-and-future-implications-for-us-foreign-policy (Accessed: 10 August 2023).

Securing Sochi: Soft Power Ambitions & Putin's Potemkin Village (2016) The Ellison Center. Available at: https://jsis.washington.edu/ellisoncenter/news/securing-sochi-soft-power-ambitions-putins-potemkin-village/ (Accessed: 10 August 2023).

Soft Power 30 (no date) Soft Power. Available at: https://softpower30.com/ (Accessed: 10 August 2023).

Soft Power and geopolitics in 2023 (2023) Diplo. Available at: https://www.diplomacy.edu/resource/soft-power-the-means-to-success-in-world-politics/ (Accessed: 02 August 2023).

Soft power: Why it matters to governments, people, and brands (2021) Brand Finance. Available at: https://brandfinance.com/insights/soft-power-why-it-matters (Accessed: 16 August 2023).

Ted Reinert, M.M., Byman, D.L. and Kalb, M. (2016) Al Jazeera: The most-feared news network, Brookings. Available at: https://www.brookings.edu/articles/al-jazeera-the-most-feared-news-network/ (Accessed: 16 August 2023).

Thomas, J. (2022) Qatar World Cup stadiums 2022: Cost, name, sizes and capacity for every pitch, Sporting News. Available at: https://www.sportingnews.com/us/soccer/news/qatar-world-cup-stadiums-2022-cost-names-size-capacity-pitch/oyhamtoorwhiltdmfdq5ej2u (Accessed: 25 August 2023).

Tom Ravenscroft |15 December 2022 Leave a comment (2022) Sixteen stadiums set to host games at the World Cup 2026, Dezeen. Available at: https://www.dezeen.com/2022/12/15/world-cup-2026-stadiums-usa-canada-mexico/#:~:text=Unlike%20the%20 Qatar%20World%20 Cup,Cup%20 stadiums%20are%20already%20 built. (Accessed: 25 August 2023).

The truth behind Qatar's luxury hotels hosting World Cup teams (no date) Business & Human Rights Resource Centre. Available at: https://www.business-humanrights.org/en/from-us/media-centre/the-truth-behind-qatars-luxury-hotels-hosting-world-cup-teams/#:~:text=Qatar%20has%20 bilt%20 over%20100,sponsors%20during%20the%20World%20Cup. (Accessed: 25 August 2023).

What is power? (no date) Hoover Institution. Available at: https://www.hoover.org/research/what-power (Accessed: 10 August 2023).

What is soft power? (no date a) Council on Foreign Relations. Available at: https://world101.cfr.org/foreign-policy/tools-foreign-policy/what-soft-power (Accessed: 16 August 2023).

What is soft power? (no date b) Soft Power. Available at: https://softpower30.com/what-is-soft-power/ (Accessed: 16 August 2023).

What is soft power? 5 examples of soft power - 2023 (no date) MasterClass. Available at: https://www.masterclass.com/articles/soft-power (Accessed: 10 August 2023).

World congress of compatriots (2015) President of Russia. Available at: http://en.kremlin.ru/events/president/news/50639 (Accessed: 10 August 2023).

Stock Price Prediction By Rhea Sawaya

Abstract

We created a stock price prediction model in this project using previous stock data primarily from Apple. We collected information from Yahoo Finance, focusing on stock "open" prices. Our Linear Regression-based model was able to predict the price for the next day based on the last two days' open prices by splitting the data into training and testing sets; however, more days of data could have been used. By training the data, we get our model to adapt to a certain pattern after which we test their capacity to predict with existing data. To see how well they performed, we used Mean Squared Error (MSE). The average squared difference between the actual and predicted outcomes is determined by MSE. A low MSE result for the model showed reliable predictions when it was examined. For example, Apple's MSE is 5.03. To help firms and investors make wise investment decisions, this model has real-world applications. We also created a trading bot where we start with $2000 and end up with $6891.

Key terms: Prediction of stock price, investment, stock data, training data, splitting data, linear regression, neural network, MSE, Open prices

Introduction and Problem Statement:

In a dynamic global capital economy, investment is an important vehicle for people to grow their wealth and ensure their future financial security by creating a safety net for unforeseen circumstances. As they invest, these individuals decide where, when, and how to allocate their financial resources with the expectation of generating profitable returns over time. On a larger scale, it fuels economic development by providing businesses with the capital needed for expansion, innovation, and job creation.

People have a diverse set of financial instruments and markets to invest their capital. From traditional options like real estate and bonds to modern options like cryptocurrencies. However, one of the most dynamic and thought-after avenues is the stock market.

The stock market, think of it like a big and busy market, is a marketplace where instead of fruits and vegetables, people buy and sell something called 'stocks'. These belong to public companies. Companies list their stocks on exchanges to allow investors to become partial owners.

But how much is a stock worth? Well, it's like an auction, the highest bidder wins. It's all about how many people want it and how many shares of this stock are available, it's called supply and demand. Investors make their decisions based on several factors such as companies' performance, economic indicators, geopolitical events, and investor sentiment.

Let's dive into the history of stock markets. The story of stock markets begins in the 1600s at the Amsterdam Stock Exchange. It was created just after the Dutch East India Company, also known as VOC, in 1602. As the banking business developed, the Philadelphia

Stock Exchange became the first stock market in America. And as of 2023, the NYSE and NASDAQ are the largest exchanges in the world, by total market capitalization.

It is important to note that stock markets can be volatile, and in some years they decline. But the ups far outnumber the downs and the long-term return for investors has been around 6,5-7% since about 1800.

Predicting future prices of stocks can increase profit for investors. Just like anything else, it brings advantages along with challenges as it involves many factors. Let's say China's economy is struggling, fewer people will purchase iPhones. That could lead to Apple expecting a sales drop for the newly released iPhone 15. That might cause a dip in their stock price. Accurate guesses of future stock prices can lead to success for investors. It informs their decisions, helping them know where and when to invest their money.

On top of that, they can control risk better. This is exactly what we are trying to do with our code. We are using companies to train and test data and find models that work best to predict the future performance of their stock prices.

Data Collection and Preprocessing:

To predict the stock prices, we first have to get information from data sources. We used Yahoo Finance and then we used Pandas, a Python tool used to clean, deal with, and manipulate the data. Then, we gather and clean the data. Our code gathers 5 years of historical stock data from any company wanted - ours being "AAPL" (Apple) and "GOOG" (Google) - using Yahoo Finance's Yfinance tool. Then, the data is cleared up by eliminating extra columns such as dates, and dividends…leaving only the Open prices. The 'Open' pricing information is then stored in a NumPy array.

Why did we choose open prices? We chose to predict the "open" price as we want to see how the price will start. That will help us have a strategy designed from previous days. An open price is the first price exchanged in a trading day. Using open prices for price prediction is helpful because it gives you the most recent information about a company's stock market and shows how traders feel about it at the start of a trading session.

Feature Selection and Engineering:

Our code uses two opening stock prices as variables, although more can be used, for predicting the next price. These forms feature set X, which combines two consecutive days of open prices. In our code, the snippet uses a loop to give numbers to our variables X and Y based on the content of our list of Apple open stock prices. In our model, we picked the opening prices of the last two days as aspects to give a more recent perspective making our model more accurate. It uses this past information to predict future stock prices.

Model Selection and Evaluation:

One of the models we used for the stock price prediction is Linear Regression. Linear regression is the process of using another, connected, and known data value to guess the value of

data that is not yet to our knowledge. How do we use it? We use the training dataset to train our linear regression model. The model will learn the coefficients for the equation of the line that best fits the data points. In this case, the equation will be: Stock Price = β0 + β1 * Open Price Today + β2 * Open Price Yesterday. β0 is the intercept. β1 and β2 are the coefficients associated with the open prices for today and yesterday, respectively.

To check how well our linear regression model works we used MSE, comparing predicted prices to existing prices from the collected data of our test set. It calculates the average squared difference between what was predicted and what happened. This is done by taking the difference between the actual and predicted numbers, squaring the difference, and then calculating its average. A smaller MSE means the model did better, with 0 being a perfect prediction.

$$MSE = \frac{1}{N} \sum_{i=1}^{N} (f_i - y_i)^2$$

where N is the number of data points, f_i the value returned by the model and y_i the actual value for data point i.

Fig 2: MSE Equation

Model Training and Optimization:

We trained our models by splitting the data into training and testing sets. In our code, we use a library called sklearn to create and train our linear regression model. The model is trained with some input and output data (X_train and Y_train), and then it makes predictions on new data (X_test). The predicted values are saved in Y_pred. It's a way to find patterns in data and make predictions based on those patterns. The training set is used to teach the model the relationships between the input features and the output also known as the target variable. The model is then trained using the training data, which represents 67% of the collected data, to find the best coefficients. The code tells the model to look for the best values for each of its coefficients and by reducing the gap between the expected and actual numbers, this is accomplished. Then the model is tested with the rest of the data representing 33% of the collected data.

Why do we split the data? The reason is quite simple. It's like the process of an exam, first, you revise for it and then you take the test to see your understanding. In this case, the model is trained by revising previous stock price patterns, and seeing how each day evolves. Then after being trained, the model is tested. The model is given 2 existing prices and it has to predict the next - already known - price. This will help us understand how the model is performing. The code evaluates the models by looking at how well their predictions compare and contrast with the actual stock prices. The metric used in this case is MSE which we talked about above. We

found that the MSE for the Apple stock price prediction is 5.03 which shows a high level of accuracy since it is close to 0, which is the ideal prediction.

Neural Network:

Imagine a neural network, shown in the image, as an AI system that helps models train data. This network has three parts: the input layer, the hidden layer, and the output layer. As seen in the image, the model starts with 3 numbers in the input part. Every line then is multiplied by each number in the hidden part until the last part. This path leads up to the output.
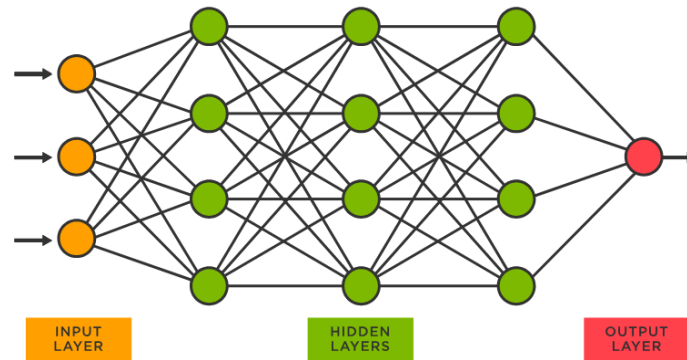
Fig 2: The layered structure of neural networks

Results and Analysis:

The results of the prediction model tell us that our linear regression model is credible. The MSE between the prediction and the data taken from the test set of 5.03 indicates that, on average, the predicted prices are almost matching to the actual prices. This shows that the model prediction is quite accurate and that our model is reliable. These results can have a great impact on future investments and the future of companies.

Table of MSE between the prediction and the data taken from the test set of the linear regression model tested on different companies on 2 iterations (each time we run a test there is always a different randomness):

Company	MSE on the first iteration	MSE on the second iteration	Average of both MSE numbers
Apple	5.03	6.27	5.65
Google	3.82	3.08	3.45
Disney	6.05	6.41	6.23
Amazon	8.18	9.46	8.82

| Nike | 6.90 | 5.11 | 6.005 |
| Under Armour | 0.22 | 0.25 | 0.235 |

Trading Bot:

Trading bots help you know when to buy and when to sell stock. In our code, we started with $2000 as our amount. We played this game where we bought or sold one stock. If the predicted price is lower than the current one then I will invest in one stock. However, if the stock is expected to increase then I sell one stock. In the end, we ended up with $6891, which is a 344% increase . Every day, we make a decision either to buy one stock or to sell one stock based on the prediction generated by our model. If the prediction shows an increase we buy one stock, if the budget allows, but on the other hand if the prediction shows a decrease we sell one stock if we have any left.

Also, there could be more aggressive ways that could be implemented, buying or selling more than 1 stock at a time.

Discussion and Interpretation:

In our code, we use the "open" prices of a stock for the previous two days to make predictions about the next day's trading price. The model uses a simple linear model and calculates the MSE. Our model can be used in real-life stock trading or investment.

For example, if our model predicts a company's share price will be lower tomorrow, then an investor who already owns that company's stock would be better off selling the stock today to avoid losses when the stock price drops tomorrow. If however the model predicts the share price of a company will be higher tomorrow, an investor who already owns the stock should keep the stock as its value will appreciate tomorrow, while an investor who does not own the stock already, can purchase the stock today to capture higher returns tomorrow.

Relying on this model across many stocks will help investors decide which stocks to buy and which stocks to sell to maximize their returns across a portfolio of shares.

Limitations and Future Work:

When we are predicting stock price, the model has some limitations and potential biases - meaning that the model is inclining towards one side of the data - that we should keep in mind. Models are trained on a limited set of historical data, and thus they did not have the chance to analyze changes throughout the company's existence. They are trained on one set of data, as such the model assumes that the market works under specific conditions. This is a problem as the model will struggle to predict stock values accurately in case of unexpected market changes. In a sense, the model is too focused on what happened in the past and not what will happen in the future.

In the future, we can improve stock prediction in several ways. For example, we can use different types of data, find better methods to analyze only the most important information,

combine different models or techniques, train the model to take into account also the news and analyst reports of the company, and finally very often run testing and validation to make sure the model is updated to new changes.

Conclusion

All in all, in this article we are discussing how to accurately predict stock prices and its importance to maximize investor returns. Our linear regression model uses Pandas and Yahoo Finance for data collection and preprocessing. The model is trained by splitting the data into a training set and a test set, and its performance is evaluated by comparing predicted and actual stock prices. Our results show that the model is accurate but has limitations and maybe biases. In future research, we would focus on improving stock price prediction models by using different types of data, analyzing only relevant information, and applying advanced machine learning methods.

Works Cited

Adam Barone "Opening Price: Definition, Example, Trading Strategies" Updated May 27, 2022
https://www.investopedia.com/terms/o/openingprice.asp

Andrew Beattie "The Evolution of Stock Exchanges" Updated December 18, 2023
https://www.investopedia.com/articles/07/stock-exchange-history.asp

By Inyoung Hwang "A Brief History of the Stock Market" June 15, 2023, · 10-minute read
https://www.sofi.com/learn/content/history-of-the-stock-market/

Jim Frost "Mean Squared Error (MSE)"
https://statisticsbyjim.com/regression/mean-squared-error-mse/

KAVITA MALI "Everything you need to Know about Linear Regression!" Updated On
November 28th, 2023
https://www.analyticsvidhya.com/blog/2021/10/everything-you-need-to-know-about-linear-regression/

Dorothy Neufeld "MARKETSMapped: The Largest Stock Exchanges in the World" October 18,
2023
https://www.visualcapitalist.com/largest-stock-exchanges-in-the-world/#google_vignette

Peter Gratton "How to Invest in Stocks: A Beginner's Guide" Updated December 22, 2023
https://www.investopedia.com/articles/basics/06/invest1000.asp

Tim Koller "Looking back: What does the 'long term' really mean?" September 29, 2022
https://www.mckinsey.com/capabilities/strategy-and-corporate-finance/our-insights/looking-back-what-does-the-long-term-really-mean

What Were the Mental Health Developments of the COVID-19 Pandemic For Those In Generation Z? By Ava Robinson

Abstract

The future of our youth's well-being was called into question by the rising number of long-lasting mental health effects induced by the COVID-19 pandemic, beginning in the year 2020. Many research studies and investigations have been done to observe the minds of young people before and after the COVID-19 pandemic. This research was completed to educate ourselves on the similarities and contrasts of mental satisfaction during both periods surrounding the pandemic. The study will show that many adverse effects resulted from the pandemic. These negative effects include eating disorders, rises in rates of depression, as well as suicidal rates among adolescents. There were also positive effects resulting from the pandemic. The most prominent positive effects include an expanded time spent with family and more time during the day to pursue their creative enjoyments (such as extracurriculars, hobbies, and interests).

Along with these effects, there was also a rise in individuals pursuing self-care, self-scrutiny, and non-family relationships. Non-family relationships refer to those who are considered as friends and online presence. It is essential to be aware of the profound effects of the COVID-19 pandemic on adolescents and young people. The available research will influence those concerned with how specific demographics live through and deal with the struggles that evolve from crises such as the 2020 COVID-19 Pandemic.

Keywords: Adolescents, COVID-19 Pandemic, mental health, long-lasting effects

Introduction

Mental health is as essential to physical health as anything and everything else. Allowing one to neglect or ignore one's mental well-being can and will be somewhat harmful, especially for adolescents. Adolescents experience much "stronger and more intense" emotions compared to many more lengths of time (KidsHelpline.com 1). This reasoning is because they are experiencing puberty, a "stage in people's lives when they develop from a child into an adult" and "...is associated with emotional and hormonal changes" (Cambridge Dictionary 1)(Breehl and Caban 1). These changes make individuals of this age susceptible to adverse mental health effects, which can have devastating consequences. Especially during the COVID-19 pandemic, a time when most of us around the world needed to follow mandatory lockdown procedures, adolescents were particularly vulnerable.

March 15th, 2020, was the day multiple states began to order lockdowns to prevent the spread of the quickly spreading and contagious virus, COVID-19 (CDC "Museum Covid-19 Timeline" 1). Originating in Wuhan, China, a situation thought to be handled quickly at first spread into a two-year lockdown that was unlike anything most individuals had ever known (CDC "Museum Covid-19 Timeline"1). Adolescents had to attend school online, which was a drastic change compared to what they were used to (WHO 1). Along with that, recreational facilities were closed, they could not interact with their friends, and there was always a feeling of an unknown future that most definitely weighed heavily on their mental health. This review will evaluate

surveys and information gathered from other research papers to answer the essential question: What were the mental health developments of the COVID-19 pandemic for those in Generation Z?

Discussion

The purpose of this review was to observe and note the information gathered from other sources surrounding the mental health developments and ramifications that occurred in adolescents during the COVID-19 pandemic. It is understandable from the information provided that a definite mental well-being result of the COVID-19 pandemic occurred. The public can recognize that although there is (understandably) great favor to discuss the harmful effects of the lockdown experience for our youth, there were also long-lasting positive effects that should be noticed in order for one to make a complete conclusion about the COVID-19 pandemic experience. Most of the research observed during the research process was centered around the consequential effects of the lockdown period and its beneficial outcomes, which is most advantageous to know. However, this area of investigation is imperative for those to understand the full effect of the pandemic on our youth and what mental health services are more crucial to place effort into than others. Helping society understand how this generation faces the impact of such a difficult time at such a vulnerable developmental stage in life will give greater insight into how mental health trends could change in the future.

Negative Mental Health Effects

In the paper by Susan Branje and Amanda Morris, three focus areas concerning the effects of the COVID-19 pandemic were measured. Data was gathered from individuals across four continents aged 9-22 years (Branje and Morris 3). First off, the emotional implications of the COVID-19 pandemic. Compared to "...before and during the first six months of the pandemic…", there was an escalation of adverse mental health effects (Branje and Morris 5). This rise was potentially derived from the bleak outlook the COVID-19 pandemic presented to individuals in this age group. The COVID-19 pandemic in 2020 was known for causing youths to feel these symptoms, along with many others, that typically "…lead to increased risk of drug use, experiencing violence, and higher risk sexual behaviors that can lead to HIV, STDs, and unintended pregnancy" (CDC "Mental Health" 22). However, there was also a reduction in everyday displeasure, "anxiety," and "self-internalizing problems" (Branje and Morris 5). The specifics of this data are displayed by an independent graph from Cambridge University (presented below):

	Pre-COVID-19 M (S.D.)	COVID M (S.D.)	F	p	Cohen's d
CDI	5.93 (5.70)	9.61 (7.74)	10.11	0.002	0.29
Females	6.49 (9.22)	10.76 (8.23)	10.13	0.002	0.34
Males	4.68 (4.09)	7.05 (5.78)	0.94	0.34	<0.01

Panic/Somatic symptoms	4.77 (4.29)	4.96 (5.03)	13.45	<0.001	0.33
Females	5.27 (4.68)	5.91 (5.41)	12.21	0.001	0.38
Males	3.64 (3.01)	2.86 (3.15)	0.01	0.99	<0.01
Generalized anxiety	5.62 (4.38)	7.62 (4.92)	20.58	<0.001	0.42
Social anxiety	4.83 (3.57)	5.43 (4.00)	7.57	0.006	0.24

Table 1: The symptoms presented before and during the COVID-19 pandemic. From Hawes et al.

5. The data above (Table 1) displays the individuals who presented "depression and anxiety symptoms before and during the pandemic" (Hawes et al. 5). The data from this paper was collected through a study of 451 individuals classified as adolescents and young adults (Hawes et al. 4).

In addition, there were other grounds as to why many youths experienced adverse mental health effects during the pandemic. For instance, "disadvantaged" students tended to experience higher levels of negative mental health symptoms. This data is because "...they experienced the loss of family income, higher rates of illness and death among community members, and problems in virtual connectivity," to name a few examples (Branje and Morris 6). This paper further proves that those considered "disadvantaged" in some form tended to experience the most harmful effects of the pandemic.

Positive Mental Health Effects

Apart from that, the paper by Branje and Morris presents evidence of what could be considered positive mental health effects resulting from the COVID-19 pandemic. Since all school-obligated youths had to receive their schooling at home and online during the lockdown period, some may regard the distance learning experience as positive. This belief could be concluded since some adolescents may learn better under the learning setting that the lockdown period provided.

Additionally, the relationship between the parents and the youths proved to be a considerable factor when considering the well-being of an individual during the COVID-19 pandemic. According to the paper, "[p]ositive relationships with parents were associated with better adjustment during the pandemic" (Branje and Morris 7). This further backs up the idea of who experiences positive mental health effects during the pandemic and why they may.

Factors Influenced by Mental Health Developments

During the pandemic, many adolescents experienced both positive and negative effects from the unique and unfortunate experience. These mental health developments influenced many aspects of their lives, including "social and academic" (Branje and Morris 9). Additionally, the social aspects of an adolescent's life were significantly affected. The lockdown period made it quite

difficult for youths to spend time with others their age and socialize like they used to before the pandemic began, causing a high level of "loneliness" to emerge (Banje and Morris 9).

The academic aspect affected by the pandemic was of great concern to many educators nationwide. It was reported that "...about 15% of adolescents reported a steeper decrease in academic well‑being, characterized by lower school engagement and higher burnout…" (Banje and Morris 11). The paper then goes on to express more in-depth how the academic aspect of an adolescent's life has been affected and gives examples to give the audience a better understanding of the topic.

Conclusion and Interpretations

In closing, the research paper exhibited much information regarding the mental health development of adolescents who experienced the effects of the COVID-19 pandemic. The data is gathered from 21 studies across four mainlands to contribute to the endeavors of this study (Banje and Morris 1). Much information was discovered about many individuals in that age range and how they may have felt during that time, including what aspects of their lives (social and academic) were affected by this worldwide experience. In this paper, many connections could be made concerning the mental health developments of individuals and other parts of their lives. For example, those who were raised in a "disadvantaged" environment tended to experience higher rates of adverse mental health effects compared to others (Branje and Morris 9). It assumes that in those environments, it may prove hard to adapt to the COVID-19 pandemic (Branje and Morris 9).

In conclusion, this research paper provides an abundance of information regarding the effect of the COVID-19 pandemic on young people around the world. Through this, one can craft a significant analysis of the future for these young individuals who went through the pandemic. These effects may emerge through national test scores, behaviors, emotional tendencies, and more. This paper was also able to inform people that there were positive mental health effects (in addition to adverse mental health effects) of the COVID-19 pandemic.

Work Cited

Breehl, Logen, and Omar Caban. "Physiology, Puberty." StatPearls [Internet]., U.S. National
Library of Medicine, 27 Mar. 2023, www.ncbi.nlm.nih.gov/books/NBK534827/.

"CDC Museum Covid-19 Timeline." Centers for Disease Control and Prevention, U.S. Department
of Health & Human Services, 15 Mar. 2023,
www.cdc.gov/museum/timeline/covid19.html#:~:text=March%2015%2C%202020,the%20s
pread%20of%20COVID%2D19.

Hawes, Mariah T., et al. "Increases in Depression and Anxiety Symptoms in Adolescents and
Young Adults during the COVID-19 Pandemic: Psychological Medicine." Cambridge Core,
Cambridge University Press, 13 Jan. 2021, https://doi.org/10.1017/S0033291720005358.

"Mental Health of Adolescents." World Health Organization, World Health Organization, 12 Nov.
2021, www.who.int/news-room/fact-sheets/detail/adolescent-mental-health.

"Mental Health." Centers for Disease Control and Prevention, Division of Adolescent and School
Health, National Center for Chronic Disease Prevention and Health Promotion, 6 Dec. 2023,
www.cdc.gov/healthyyouth/mental-health/index.htm#:~:text=Mental%20health%20problem
s%20in%20youth,%2C%20STDs%2C%20and%20unintended%20pregnancy.

"Mood Swings and Puberty." Kids Helpline, Kids Helpline, 11 Oct. 2023,
kidshelpline.com.au/parents/issues/mood-swings-and-puberty#:~:text=During%20puberty%
20your%20child%E2%80%99s%20emotions,angry%20and%20not%20know%20why.

"Puberty | Definition in the Cambridge English Dictionary." Cambridge Dictionary, Cambridge
Dictionary, dictionary.cambridge.org/us/dictionary/english/puberty. Accessed 1 Feb 2024.

Branje, Susan, and Amanda Sheffield Morris. "The Impact of the COVID-19 Pandemic on
Adolescent Emotional, Social, and Academic Adjustment." Journal of Research on
Adolescence: the official journal of the Society for Research on Adolescence vol. 31,3 2021:
https://doi.org/10.1111/jora.12668

Impact Food Pricing has on the Diet Quality of Low-Income Households in the U.S.
By Hannah Machleidt

Abstract

Investigation about food pricing is essential when researching the dietary quality of low income American households. There is a strong positive correlation between a more nutrient dense diet and higher costs. There is also a positive association between a less nutrient dense diet and lower costs. To investigate these topics, numerous tools are utilized to assess diet quality. Some of the most common are the Healthy Eating Index, Food Frequency Questionnaire, and 24 Hour Dietary Recall. In addition, possible associations between diet quality and health outcomes, diet quality and price, and diet quality and low income households have been investigated. It's shown that there has been an increase in the prevalence of type 2 diabetic trends. This has shown to be connected to diet quality as diet quality is negatively associated with the risk of developing type 2 diabetes. This is also why low income households are especially at risk for type 2 diabetes. Low income households are shown to have low diet quality and households with higher incomes have shown to have a correlation with a high, more nutrient dense diet. It is important to note that food pricing may not be the only factor in poor diets and impact on low income households in the US. Factors like food deserts and insecurity should also be investigated and require further research. Investigating all factors of poor diet quality is important so that we can identify sources of inequity within our food systems, and improve diet quality for all Americans.

Keywords
Health outcomes, dietary recommendations, diet costs, nutrition, dietary patterns, socioeconomic status

Introduction

Low-income households are defined as an annual family income equal to or below 200 percent of the Federal poverty threshold based on the size of the family (U.S. Department of Agriculture- Documentation). To provide an example, the weighted average poverty threshold for a family of four in 2022 was about 30,000 USD (United States Census Bureau- Poverty Thresholds). In 2022, 11.5% of American Households were considered impoverished (37.9 million people) (*United States Census Bureau- Poverty in the United States: 2022)*. Diet quality in the US is most commonly determined by how closely an individual's diet abides by the recommendations in the Dietary Guidelines for Americans (DGA) (*U.S. Department of Agriculture- Healthy Eating Index (HEI)*).

The DGA recommends three dietary patterns for a healthy lifestyle with the purpose of maintaining a healthy weight and promoting overall health. Those dietary patterns include The Healthy U.S.-Style Dietary Pattern which is in accordance with type and proportion of foods typically consumed by the average American but in a more nutrient dense form in appropriate amounts. The Healthy Vegetarian Dietary Pattern and The Healthy Mediterranean-Style Dietary

Pattern are both variations that also are recommended. These dietary patterns typically recommended similar serving amounts for various food groups with some variation.
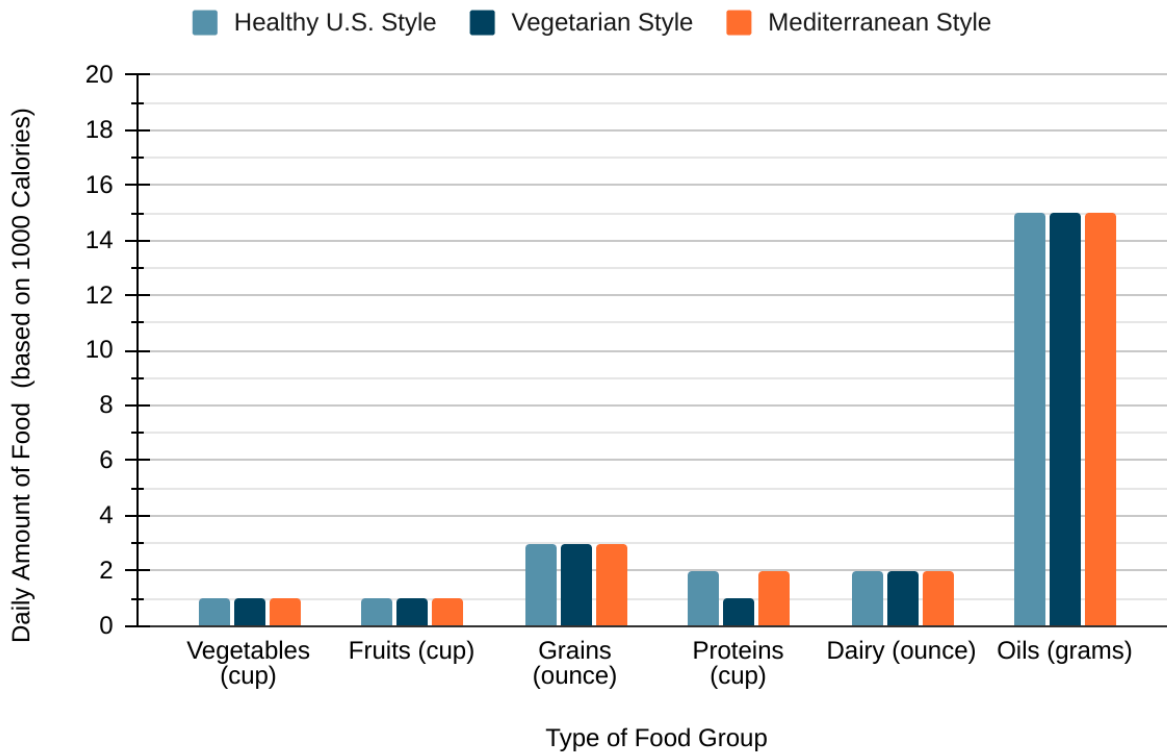
Figure 1. Different dietary style patterns for individuals aged 2 yrs and older

      In addition to the dietary patterns presented above, some core recommendations were included. Some examples were vegetables (all types), fruits (preferably whole), grain (at least half that are whole grain), protein foods, and oils (U.S. Department of Agriculture and U.S. Department of Health and Human Services. *Dietary Guidelines for Americans, 2020-2025)*.

      One of the most extensively used measures of diet quality in the US is the Healthy Eating Index (HEI), which assesses the quality of food based on these dietary patterns and key recommendations from the DGA. The HEI updates every 5 years with the most recent version being from 2020. It utilizes a scoring system to analyze food groups and give an overall score out of 100 on an individual's diet (*U.S. Department of Agriculture- Healthy eating Index (HEI)*) .

Table 1. Common research tools used to collect information on an individual's diet.

Research Tool Type	Description of Research Tool	References
Food Frequency Questionnaire (FFQ)	A checklist consisting of foods and beverages used to determine how often a subject	*Food Frequency Questionnaire At A Glance.* *https://dietassessmentprimer.c*

	consumed each item over a specific period of time	*ancer.gov/profiles/questionnaire/* Accessed on 3rd January 2024
24 Hour Dietary Recall	Subjects report the foods and beverages consumed (and their quantities) in the past 24 hours. Commonly done through interview	*24-hour Dietary Recall (24HR) At a Glance.* *https://dietassessmentprimer.cancer.gov/profiles/recall/* Accessed on 3rd January 2024
3 Day Food Diary	Subject records the foods and beverages consumed (and their quantities) over a 3 day timeframe. Typically includes 2 days from the working week and 1 day from the weekend (ex: Thursday, Friday, Saturday)	*Food Record At A Glance.* *https://dietassessmentprimer.cancer.gov/profiles/record/* Accessed on 3rd January 2024

It is important to note the increase in poverty in the US. In 2020, the poverty rate in the US was 11.4% (37.2 million people). This was a 1% increase from 2019 (Schrider et al., 2021). In 2021, the poverty rate was measured at 11.6% or 37.9 million people. The measure used to determine these numbers was the Official Poverty Measure that defines poverty based on pretax money income in comparison to a poverty threshold based on family size (Creamer et al.,2022). This indicates that whatever impacts food pricing may have on low income populations will increase as the number of households affected by poverty increase.

Studies have also been conducted that investigated the relationship of food pricing to diet quality. Food pricing can be defined as the cost to purchase a specific food item in a specific region/location. Overall food pricing may have an impact on the diet quality of low-income households because of how it provides accessibility to nutritious foods. The reason for this may be because of families having difficulty to afford nutrient dense food options and opting for energy dense food choices. This means that meals feel fulfilling to the consumer but do not provide adequate nutrients for the body to function. Any possible impacts of food pricing on diet quality will be explored in this review paper.

Health Outcomes

Type 2 diabetes has gained a stronger presence in the US population. A study was conducted to investigate trends in diabetes (both type 1 and 2) in American youth and adolescents. An observational, cross-sectional, multicenter study was conducted and all

individuals were under 20 years of age and had diagnosed diabetes. Data was collected in 2001, 2009, and 2017 from Colorado, Ohio, South Carolina, and Washington state and Native American reservations in specific locations in New Mexico and Arizona. This study found a noticeable increase in the prevalence of type 2 diabetes in the youth population. Starting from 0.34 out of 1000 youths in 2001, to 0.46 in 2009, and to 0.67 in 2017. This represents a 95.3% relative increase over 16 years (Lawrence et al., 2021). Possible causes could be an increase in poverty in the U.S. Although there may be other factors that influence this increase that have not been explored, one notable factor is diet quality.

There is an association between diet quality and prevalence of type 2 diabetes. In a study conducted to investigate the relationship between the risk of type 2 diabetes and diet quality in US women, the researchers found evidence of an inverse association between diet quality and risk of type 2 diabetes. The participants of the study were from the Nurses' Health Study II (NHS II), which, beginning in 1989, is a currently ongoing prospective cohort study. All of the women were between the ages of 27-44 years of age. A Food Frequency Questionnaire was used to collect information on the participants' eating habits and diet. This was sent out every 4 years. To assess diet quality, the Global Diet Quality Score was used. The GDQS was also compared to the Minimum Diet Diversity score for Women (MDD-W) and the Alternate Healthy Eating Index-2010 (AHEI-2010). The duration of the study lasted 26 years. A limitation of the study is that since the information about diet is self-reported, it is subject to bias from the reporter. Thus, it creates possible inaccuracies within diet quality.

When observing the relationship between low risk of diabetes and high GDQS, the association for women under 50 years of age was 0.85, and 0.82 for women above or equal to 50 years of age. The AHEI-2010 also provided an inverse association between diet quality and risk for type 2 diabetes. Overall, the results of the study provided evidence to suggest an inverse association with a high diet quality score and diabetes risk (Fung et al., 2021).

Many of the diet-related health effects are also more prevalent in low income communities in the US. In 2019, men and women below the federal poverty line were the most prevalent group with self-reported diagnosed type 2 diabetes (13.7% for men, and 14.4% for women). In addition, 13.4% of adults with diagnosed diabetes had less than a high school education, 9.2% of diagnosed adults, had a high school education, and 7.1% had more than a high school education (*Centers for Disease Control and Prevention- Prevalence of Diagnosed Diabetes*). High school education can be a common determinant of socioeconomic status which pertains to low income status.

Food prices, as well as poverty and type-two diabetes rates have all increased over the years. Studies have also presented evidence to show a possible association between diet quality and risk of type two diabetes. Diabetes rates are shown to be the most prevalent in low-income communities and households, indicating that there may be a correlation between all of these aspects. This may be due to the fact that increased poverty can cause more difficulty to attain healthier foods. When households don't have adequate foods, their diet quality decreases and increases risk of developing Type 2 diabetes.

Relationship Between Food's Nutritional Value and Their Pricing

The access to healthy food may be impacted by the price of the food. If low income families are not able to attain nutritious foods, it makes it difficult to achieve a high diet quality. This can increase chances of diet-related health issues like Type 2 diabetes. That is why it is important to investigate the relationship between food's nutritional value and their pricing. There is evidence to suggest a strong correlation between food pricing and the nutritional value of foods. Numerous studies investigate this correlation.

To reestablish the relationship between the price of food, energy, and nutrients, contemporary data was used on nutrient composition and food prices were extracted from the US Department of Agriculture (USDA). To investigate the nutritional value of foods, the USDA Food and Nutrient Database for Dietary Studies was used to analyze data from What We Eat in America. To determine food pricing The Center for Nutrition Policy and Promotion (CNPP), a food price database, was used. It used information based on the 2001–2002 National Health and Nutrition Evaluation Survey (NHANES). Evidence suggested that fats, oils, and total and added sugars were significantly associated with lower food costs per 100g compared to fruits and vegetables. Meat had the highest price per 100g, a significant difference compared to any other food group. Fats, oil, total and added sugars were all foods deemed to have an overall lower nutritional value in comparison to the other food groups. The study provided evidence to suggest that foods with higher nutritional value were more expensive (Drewnowski, 2010).

In another study, diets with lower nutritional value were associated with lower costs. This research paper investigated how food prices were associated with HEI-2010 scores in young adults. The adults were above or equal to the age of 20 years. The researchers hypothesized that those with higher HEI 2010 scores were due to a more costly diet. The study represents US adults between 2007 and 2010. The database used to determine food pricing was the USDA Center for Nutrition Policy and Promotion (CNPP) national food prices database. The results showed evidence to suggest that there was a significant positive association between higher diet costs and a higher HEI 2010 score. There was also evidence to suggest that lower income family to poverty ratio was associated with lower diet costs and HEI 2010 scores. Overall the evidence showed a correlation between high cost and higher quality of diets (Rehm et al., 2015).

In addition, prices of diets appear to correlate with Americans' compliance to the recommendations set out by the DGA. One study examined this correlation utilizing two measures of food spending (self-reported food spending and Food Frequency Questionnaire (FFQ)) and made a comparison with scores from the Healthy Eating Index (HEI) 2015. The participants in the study were adults from the ages of 21-59 years and many were recruited from lower income neighborhoods. The study was located in Washington State and was conducted in 3 counties. Food prices were collected by name and location of participants' primary food store through self-reports. Monthly at-home food expenditure data was also collected through self reports based on National Health and Nutrition Examination Surveys (NHANES) questions. Results presented evidence to suggest that those who were on food assistance were associated

with lower food expenditures and diet costs. Evidence was also provided to suggest that there was a positive association of diet costs and food expenditures to diet quality (Rose et al, 2020).

An additional study further solidified the association between diet cost and diet quality. In this study, the researchers hypothesized that low cost diets among the women from California would be more dense in energy but have low nutritional value. Low income women were defined in this study as those who were equal to or below 185% of the poverty line. The women in the study were between the ages of 22 to 55 years old. To collect data on diet quality, the Food Frequency Questionnaire (FFQ) was used. A respondent would record portion size and frequency of foods she consumed out of 152 foods and beverage line items listed on the FFQ. This took place over the time period of three months. Diet cost was assessed through utilizing the prices of various local markets around the region. The results presented evidence that suggests that low-cost diets were associated with a significantly higher amount of saturated fat, total fat, and dietary energy density. There was also evidence to suggest that low cost diets were associated with a significantly lower intake in vitamins C and A. Evidence was provided to suggest that higher diet costs were associated with significantly lower dietary energy density, total fats, saturated fats, added sugars, and total energy. Evidence also suggests higher diet costs were associated with significantly higher intake of vitamin A. In conclusion the study provided evidence to suggest a higher cost for a more nutrient dense diet (Townsend et al., 2009). Foods that had a higher nutrient density were considerably more expensive than those with a lower nutrient density. Overall diet costs were also more expensive with diets of higher quality compared to diets of lower quality. Diets that were the most closely aligned with the recommendations of the DGA were also higher in costs in comparison to diets that were less aligned with those recommendations. It is clear that there is a possible direct association between diet cost and quality.

Relationship Between Low Income Households and Diet Quality

With evidence to suggest a higher cost from more nutrient dense diets (Townsend et al., 2009), research has been conducted to study diet quality of low income households. One research study was located in the Southeast of the US and the participants were recruited from two urban locations characterized by high household poverty and high percentages of racial and ethnic minority residencies. All participants were at least 18 years of age and consisted of predominantly low income African American women. Part of the researcher's hypothesis was that higher income would be positively associated with meeting the dietary guidelines of the US. Data was collected through a 24-hour dietary recall and dietary quality was assessed through the Healthy Eating Index 2010 (HEI 2010). The results showed that in comparison to the highest income referent group (≥$20,000), the lowest income group was less likely to meet the carbohydrate (61% vs 45%), fruit (24% vs 12%), and combined fruit and vegetable (20% vs 8%) guidelines. Although results indicated only a relatively small number of associations found between income and meeting dietary guidelines, the researchers noted that the finding may be a result of the homogeneity in the sample. The paper referenced larger and more diverse national

samples that had found evidence of an association between income and meeting the dietary guidelines (Wilcox et al., 2020).

Another study investigating diet quality and socioeconomic status also indicates a correlation between income and diet quality. The study was conducted in 2008 to 2009 and was located in King County of Washington state. The study consisted of 1226 adults (over 18 years of age) and a telephone survey was used to determine economic and social status. Households below a certain income were oversampled. To determine low-income households, overall household income and education level were used. In addition, a Food Frequency Questionnaire was utilized to collect dietary data about the participants. To determine diet quality, energy density and Mean Adequacy Ratio (MAR) was used.

The results of the study provided evidence to suggest an association between a higher MAR score and a significantly higher proportion of those with higher income (increased from 29% to 63% across extreme quintiles). A higher MAR score is a positive indication for good diet quality. Overall there was strong indication to show that higher income was associated with a more nutritional diet. A limitation presented in the study was that collected data through self reported surveys which can be subject to biases (Monsivais et al,. 2012).

The correlation between diet quality and income is again reinforced by another study that tracked the diet quality of American adults from 1999 to 2010. Participants were adults between the ages of 20 and 85 from various socioeconomic groups. Their dietary data was collected using a 24 hour dietary recall and the diet quality of all participants was assessed through the Alternate Healthy Eating Index 2010 (AHEI 2010). Results showed for all groups over the 12 year period an increase in AHEI component scores for sugar-sweetened beverages and fruit juice (0.9 points), whole fruit (0.7 points), whole grains (0.5 points), and nuts and legumes (0.4 points). Although there was a significant decrease for sodium intake (0.5 points). Results also showed a significant increase in AHEI scores in most socioeconomic groups. The group with the highest income had been shown to have an accelerated increase in their scores. The AHEI scores of higher income groups were consistently higher than the lower income group scores. In addition, the gap between the AHEI scores between the higher and lower socioeconomic groups increased over time. (Wang et al., 2014).

Based on the research studies presented, income and socioeconomic status are likely to be positively associated with diet quality. Lower income households were less likely to follow the US dietary guidelines and there was a positive association between income and meeting the dietary guidelines (Wilcox et al., 2020). And while diet quality overall has increased over the years, the gap between higher income and lower income households in terms of diet quality has widened (Wang et al., 2014).

Conclusion

As shown in the studies above, diet costs have a strong association with their nutritional value. There is a strong positive association with diet quality and cost. Higher diet costs were shown to have more nutritional value compared to lower diet costs. In addition, lower income

households were also shown to have a lower diet quality in comparison to households with higher diet quality. These associations provide indications to suggest that diet cost is a factor in why low income households have lower diet quality. These correlations can have major negative impacts on public health. Lower quality diets have shown to have an association with prevalence of type 2 diabetes in lower income households. Certain areas that were not addressed in the paper were other influences. Diet quality is not solely influenced by food pricing and other factors need to be investigated as well. To continue to understand this issue and create solutions, we must investigate factors like food deserts, lifestyle choices, food preparation and see how those factors influence diet quality as well. To improve the health and diets of low income households in the U.S and create an intervention, diet cost must be a factor that is taken in consideration.

Works Cited

U.S. Department of Agriculture- Documentation.
https://www.ers.usda.gov/data-products/food-access-research-atlas/documentation/#:~:text=Low%20income%20is%20defined%20as,poverty%20threshold%20for%20family%20size. Accessed on 24th July 2023

U.S. Department of Agriculture and U.S. Department of Health and Human Services. *Dietary Guidelines for Americans, 2020-2025*. 9th Edition. December 2020. Available at DietaryGuidelines.gov. Accessed on 3rd January 2024

U.S. Department of Agriculture- Healthy eating Index (HEI).
https://www.fns.usda.gov/cnpp/healthy-eating-index-hei#:~:text=The%20Healthy%20Eating%20Index%20(HEI,for%20Americans%20(Dietary%20Guidelines).

Accessed on 24th July 2023

Food Frequency Questionnaire At a Glance.
https://dietassessmentprimer.cancer.gov/profiles/questionnaire/

Accessed on 3rd January 2024

24-hour Dietary Recall (24HR) At a Glance.
https://dietassessmentprimer.cancer.gov/profiles/recall/

Accessed on 3rd January 2024

Food Record At A Glance.

https://dietassessmentprimer.cancer.gov/profiles/record/

Accessed on 3rd January 2024

Shrider, Emily A., et al. "Income and Poverty in the United States: 2020." *U.S. Census Bureau*, 14 September 2021, https://www.census.gov/library/publications/2021/demo/p60-273.html. Accessed on 2nd September 2023.

Creamer, John, et al. "Poverty in the United States: 2021." *U.S. Census Bureau*, 13 September 2022, https://www.census.gov/library/publications/2022/demo/p60-277.html. Accessed on 2nd September 2023.

Lawrence JM, Divers J, Isom S, Saydah S, Imperatore G, Pihoker C, Marcovina SM, Mayer-Davis EG, Hamman RF, Dolan L, Dabelea D, Pettitt DJ, Liese AD, Trends in Prevalence of Type 1 and Type 2 Diabetes in Children and Adolescents in the US, 2001-2017, JAMA, 2021, 326 (8), 717-727, DOI: 10.1001/jama.2021.11165

Fung TT, Li Y, Bhupathiraju SN, Bromage S, Batis C, Holmes MD, Stampfer M, Hu FB, Deitchler M, Willett WC, Higher Global Diet Quality Score Is Inversely Associated with Risk of Type 2 Diabetes in US Women, J Nutr, 2021, 151 (12 Suppl 2), 168-175, DOI: 10.1093/jn/nxab195

Centers for Disease Control and Prevention- Prevalence of Diagnosed Diabetes.
https://www.cdc.gov/diabetes/data/statistics-report/diagnosed-diabetes.html.

Accessed on 24th September 2023

Drewnowski Adam, The cost of US foods as related to their nutritive value, Am J Clin Nutr., 2010, 92 (5), 1181-1188, DOI:10.3945/ajcn.2010.29300

Rehm CD, Monsivais P, Drewnowski A, Relation between diet cost and Healthy Eating Index 2010 scores among adults in the United States 2007-2010., Prev Med, 2015, 73, 70-75, DOI: 10.1016/j.ypmed.2015.01.019.

Rose CM, Gupta S, Buszkiewicz J, Ko LK, Mou J, Cook A, Moudon AV, Aggarwal A, Drewnowski A, Small increments in diet cost can improve compliance with the Dietary Guidelines for Americans. Soc Sci Med, 2020, 266, 113359, DOI:10.1016/j.socscimed.2020.113359.

Townsend MS, Aaron GJ, Monsivais P, Keim NL, Drewnowski A, 2009. Less-energy-dense diets of low-income women in California are associated with higher energy-adjusted diet costs2. The American Journal of Clinical Nutrition, 2009, 89(4): 1220-1226, DOI:10.3945/ajcn.2008.26916.

Wilcox S, Sharpe PA, Liese AD, Dunn CG, Hutto B., Socioeconomic factors associated with diet quality and meeting dietary guidelines in disadvantaged neighborhoods in the Southeast United States, Ethn Health, 2020, 25 (8), 1115-1131, DOI:10.1080/13557858.2018.1493434

Monsivais P, Aggarwal A, Drewnowski A. Are socio-economic disparities in diet quality explained by diet cost? J Epidemiol Community Health, 2012, 66(6), 530-535, DOI: 10.1136/jech.2010.122333.

Wang DD, Leung CW, Li Y, Ding EL, Chiuve SE, Hu FB, Willett WC. Trends in dietary quality among adults in the United States, 1999 through 2010, JAMA Intern Med, 2014, 174(10), 1587-1595, DOI: 10.1001/jamainternmed.2014.3422.

Sensitivity of Chaotic Nature Dynamics of Snowshoe Hare Population Using Logistic Map
By Shaurya Seam

Abstract
　　Chaos theory is a branch of physics and mathematics that studies the behavior of complex dynamical systems characterized by their high sensitivity to initial conditions. The effect is popularly referred to as the butterfly effect. It tries to understand natural phenomena' unpredictable, complex, and intricate behavior. Population growth can display chaotic and unpredictable behavior due to its sensitivity and various interacting factors. Thus, chaos theory can be used to describe the irregularity and unpredictability of population growth. The research aims to examine the role of chaos theory in understanding the fluctuations and long-term patterns of snowshoe hares' population. The snowshoe hare species, a member of the Leporidae (rabbit and hare) family, is subject to tremendous fluctuation and chaotic behavior. Populations of snowshoe hares cycle every 8 to 11 years, during which densities can change by a factor of 5 to 25. Through data and graphical analysis, a mathematical connection was drawn between the real-life recorded data of the specie's population and the chaotic behavior in the population dynamics through the famous logistic map equation. It was observed that the population was prone to high sensitivity and a chaotic growth rate in the early 1860s and through the 1880s. According to the logistic map equation, the conditions provided in these years are ideal for chaotic population dynamics.

Keywords
Chaos theory, Butterfly effect, population growth, snowshoe hare, logistic map, sensitivity

Introduction
　　Population growth has long captivated the attention of scientists, who diligently analyze its trends and patterns throughout the years and potentially forecast its future trajectory. Interestingly, the patterns uncovered in this pursuit often profoundly connect to the principles of chaos theory. Chaotic behavior can be observed in population systems, making them highly unpredictable in the long term.[1] Often, mathematical models are used to analyze and predict population behavior. In the 1970s, ecologists embraced the concept of chaos by introducing the "logistic map," a tool developed by Robert May.[2] This diagram reveals how chaos emerges in population growth models and other systems.

The equation represents a simple mathematical model that describes the growth of a population over discrete time steps:

$$x_{n+1} = kx_n(1 - x_n)$$

This, x_n represents the normalized population for the year (n), and x_{n+1} represents the population for the following year. The parameter (k) represents the growth rate of the population or the sensitivity. The term $(1 - x_n)$ is used as a limiting factor, which more or less represents the death rate.

It was observed that, for a particular value of sensitivity, the population either seemed to stabilize, oscillate, or display chaotic behavior after some years.
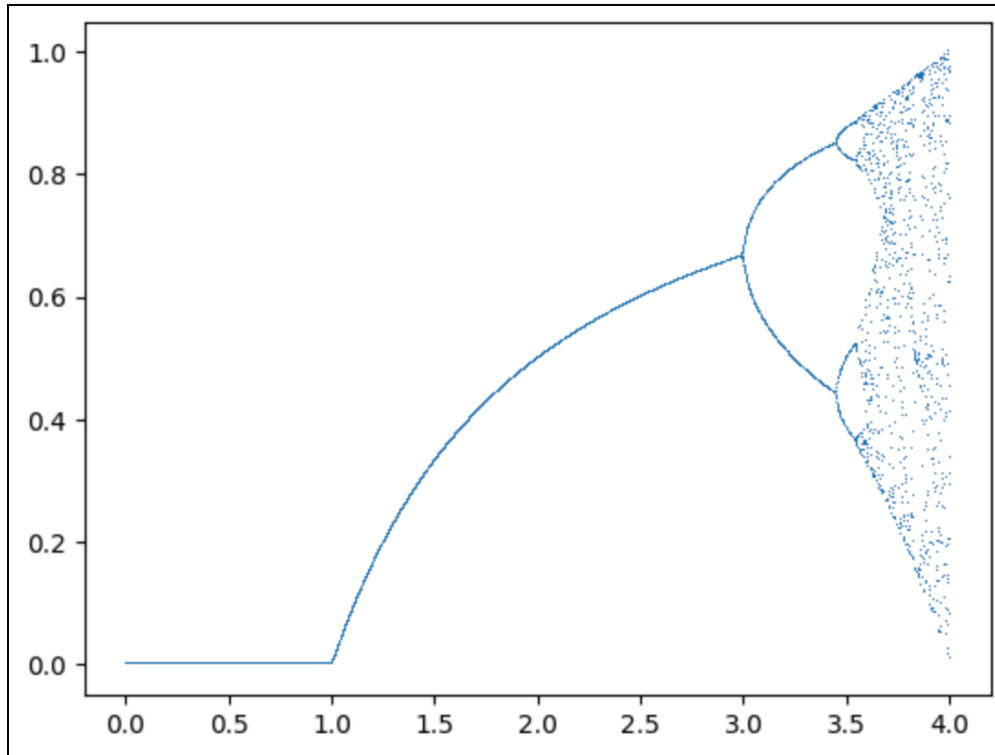
Figure 1: Bifurcation diagram of the logistic map made using Python Code.[3] The graph represents the logistic map equation sensitivity (k) on the x-axis and the corresponding population value of stabilization on the y-axis. It shows the chaotic nature of the equation. If we were to plot a diagram of the sensitivity on the x-axis and the corresponding population value of stabilization on the y-axis, we would get the famous 'Bifurcation Diagram,'[1] as represented in Figure 1. We can draw the following general inferences from Figure 1:

Table 1: Behavior of the population at different values of sensitivity.[4]

K value (sensitivity)	Inference
$0 < k < 1$	The population dies out completely after some time
$1 < k < 3$	Higher equilibrium for higher sensitivity
$3 < k < 3.56$	Oscillation between values. As we progress, we observe period-doubling bifurcation, with oscillation between 2^n values
$k > 3.56$	Complete Chaotic Nature

The logistic map equation shows different outcomes for different values of sensitivity (k), as shown in Table 1. Still, the property of universality was also shown in a chaotic system. It was observed that the ratio of consecutive bifurcation lengths was ~4.669.[1] This is famously known as *Feigenbaum's constant,* as shown in Figure 2.

$$\delta = \lim_{n \to \infty} \frac{a_n}{a_{n+1}} = 4.6692016091 \dots,$$

Figure 2: Feigenbaum's constant from the ratio of consecutive lengths.[1] The figure shows the derivation of Feigenbaum's constant from the equation, which is the ratio of consecutive bifurcation lengths.

Chaos is characterized by its high sensitivity to initial conditions. Such chaotic systems are deterministic, yet their accuracy cannot be relied upon due to the high scope of uncertainty and unpredictability. The Butterfly Effect, derived from chaos theory, expands the reasoning of how tiny changes in one part of a system can lead to significant differences in another part of the system over time.[5]

Chaos theory has a wide range of applications, ranging from economics to music.[6] The theory is widely used in studying the population dynamics of species, as explained above.

Almost every species exhibits chaotic trends in population in some form. Still, the snowshoe hare species, a member of the Leporidae (rabbit and hare) family, is subject to tremendous fluctuation and chaotic behavior.[7-8] Populations of snowshoe hares cycle every 8 to 11 years, during which densities can change by a factor of 5 to 25.[7-8] Due to their chaotic nature, the causes of the cyclic fluctuations of snowshoe hares are often debated among scientists. There have been many demographic experiments over the years that examine the population of snowshoe hares, but none focus on the chaotic nature of it.

Methodology

Aim of the study

This research paper aims to examine the demography of snowshoe hare and how it can be connected to the logistics map equation to reveal its chaotic nature over different years.

Research Design

This analytical paper will draw out the inference of chaotic nature by calculating the sensitivity of the population for different years using the logistic map equation.

Scales/Tools used

The paper extensively uses Python in Google Collab's environment to draw out data and perform graphical analysis. The data set used was sourced from a GitHub notebook.[9-10-11] Python libraries like Pandas[12] and Matplotlib[13] were used for data analysis and visualization.

Data Collection

The calculations will be performed on real-life collected data on the snowshoe hare population, recorded by *The Hudson Bay Company* in Canada between 1845 and 1935.[9] A CSV (comma-separated value) file of the dataset was provided on GitHub.[10-11] The data provides values for hare and lynx populations over 90 years.

Approach

To draw inferences about the chaotic nature of snowshoe hare demography, multiple methodological approaches can be employed. Initially, after calculating the sensitivity for each year, the approach involved determining the average sensitivity (k-value) and plotting a graph to depict what the demographic trend would have been if the sensitivity had remained constant over the years. This plot could then be compared with real-life data to analyze differences.

However, this method provides limited insight into the chaotic nature of the demography, as the k-value in reality is influenced by various environmental and external factors and is never consistent. A more appropriate measurement involves examining the variability in sensitivity over the years and identifying the years where the k-value exceeded 3.56.

The final approach incorporates both methodologies. To demonstrate the chaotic nature of demography for k-values greater than 3.56, we can calculate and plot the population demography assuming a consistent k-value determined by the logistic map equation. This allows for a comparative analysis between the theoretical and actual demographic trends, highlighting the influence of chaotic dynamics.

Result

Since the research aims to examine the real-world population demography of snowshoe hares, it would require a reliable, acceptable dataset that has been made public. Alfred J. Lotka and Vito Volterra both separately devised the predator-prey model in the 1920s. *The Lotka-Volterra model*[14] is examined in this problem using information on lynx and snowshoe hares in northern Canada. *The Hudson Bay Company* maintained accurate data on the number of animals trapped in Canada between 1845 and 1935, which should reflect their relative populations.[9]

In short, the dataset provided a population count of snowshoe hares and lynx (in thousands) over a period of 90 years in northern Canada.

This research is only concerned with the snowshoe hares' population and their chaotic behavior.

Continuing, only the required data on snowshoe hares was filtered, and the column concerning the population of lynx was dropped:

Input Code 1: Reading the CSV dataset and defining variables

```
#Reading original data
import pandas as pd
url = 'http://people.whitman.edu/~hundledr/courses/M250F03/LynxHare.txt'
df = pd.read_csv(url, delim_whitespace=True, header=None, index_col=0)
df.index.name = 'Year'
```

```
df.columns = ['Hare', 'Lynx']
df.drop(columns='Lynx',inplace=True)
df
```

Output Code 1:

Table 2: Dataset reading in Python.[11]

Year	Hare	Year	Hare
1845	19.58	1891	41.65
1846	19.60	1892	52.34
1847	19.61	1893	53.78
1848	11.99	1894	70.40
1849	28.04	1895	85.81
1850	58.00	1896	56.69
1851	74.60	1897	16.59
1852	75.09	1898	06.16
1853	88.48	1899	02.30
1854	61.28	1900	12.82
1855	74.67	1901	04.72
1856	88.06	1902	04.73
1857	68.51	1903	37.22
1858	32.19	1904	69.72
1859	12.64	1905	57.78
1860	21.49	1906	28.68
1861	30.35	1907	23.37

1862	02.18	1908	21.54
1863	152.65	1909	26.34
1864	148.36	1910	53.10
1865	85.81	1911	68.48
1866	41.41	1912	75.58
1867	14.75	1913	57.92
1868	02.28	1914	40.97
1869	05.91	1915	24.95
1870	09.95	1916	12.59
1871	10.44	1917	04.97
1872	70.64	1918	04.5
1873	50.12	1919	11.21
1874	50.13	1920	56.60
1875	101.25	1921	69.63
1876	97.12	1922	77.74
1877	86.51	1923	80.53
1878	72.17	1924	73.38
1879	38.32	1925	36.93
1880	10.11	1926	04.64
1881	07.74	1927	2.54
1882	09.67	1928	01.80
1883	43.12	1929	02.39
1884	52.21	1930	04.23

1885	134.85	1931	19.52
1886	134.86	1932	82.11
1887	103.79	1933	89.76
1888	46.10	1934	81.66
1889	15.03	1935	15.76
1890	24.20		

Table 2, a 'pandas' table assigned the name 'df' in the Python code, is the entire dataset upon which we will be performing our functions and calculations. We can plot the values using Matplotlib functions (Figure 3) and confirm whether the data matches the one provided or not:

Input Code 2: Plotting the dataset using Matplotlib library

```
#Plotting original data
import matplotlib.pyplot as plt
%matplotlib inline
df.columns = ['Hare']
plt.figure(figsize=(12, 5))
df['Hare'].plot(grid=True, label='Line Plot')
plt.scatter(df.index, df['Hare'], color='blue', label='Scatter Plot')
plt.xlabel('Year')
plt.ylabel('Hare Population')
plt.xticks(df.index[::5])
plt.legend()
plt.show()
```

Output Code 2:
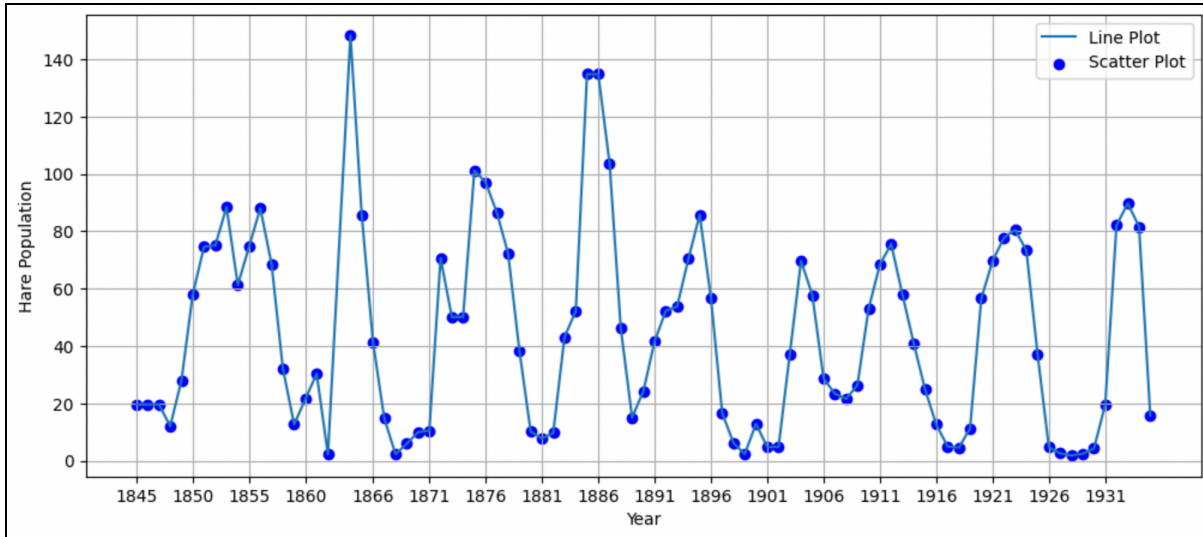
Figure 3: Plot of the hare population on Python. The graph represents the snowshoe hare population for each year (line plot and scatter plot). The values are the same as the ones provided in Table 2.

Clearly, the code is ready to proceed with further analysis. The values must be normalized since the codes will compare the dataset with the logistic map equation. Values are normalized when divided by the highest value in the data set. In the same code, the highest value of the hare population in the dataset can be found, as well as the corresponding year:

Input Code 3: Obtaining the maximum value and corresponding index label

```
#Obtaining max value and corresponding index label

hare_max = df['Hare'].max()
print(hare_max)

index_value = df.index[df['Hare'] == hare_max]
print(index_value)
```

Output Code 3:

```
152.65
Int64Index([1863], dtype='int64', name='Year')
```

The highest population count of snowshoe hares observed was 152.65 (in thousands) in 1863. We will keep the normalized value for each in their corresponding rows as a new column, as done in the following Table 3.

Input Code 4: Normalizing the values of the population

```
#Normalizing data

df2 = df[['Hare']].copy()
df2['Normalized_Hare'] = df2['Hare'] / hare_max

df2
```

Output Code 4:
Table 3: Updated table with normalized values included.

Year	Hare	Normalized_Hare	Year	Hare	Normalized_Hare
1845	19.58	0.1283	1891	41.65	0.2728
1846	19.60	0.1284	1892	52.34	0.3429
1847	19.61	0.1285	1893	53.78	0.3523
1848	11.99	0.0785	1894	70.40	0.4612
1849	28.04	0.1837	1895	85.81	0.5621
1850	58.00	0.3800	1896	56.69	0.3714
1851	74.60	0.4887	1897	16.59	0.1087
1852	75.09	0.4919	1898	06.16	0.0404
1853	88.48	0.5796	1899	02.30	0.0151
1854	61.28	0.4014	1900	12.82	0.0840
1855	74.67	0.4892	1901	04.72	0.0309
1856	88.06	0.5769	1902	04.73	0.031
1857	68.51	0.4488	1903	37.22	0.2438
1858	32.19	0.2109	1904	69.72	0.4567
1859	12.64	0.0828	1905	57.78	0.3785
1860	21.49	0.1408	1906	28.68	0.1879
1861	30.35	0.1988	1907	23.37	0.1531

1862	02.18	0.0143	1908	21.54	0.1411
1864	148.36	0.9719	1909	26.34	0.1726
1865	85.81	0.5621	1910	53.10	0.3479
1866	41.41	0.2713	1911	68.48	0.4486
1867	14.75	0.0966	1912	75.58	0.4951
1868	02.28	0.0149	1913	57.92	0.3794
1869	05.91	0.0387	1914	40.97	0.2684
1870	09.95	0.0652	1915	24.95	0.1634
1871	10.44	0.0684	1916	12.59	0.0825
1872	70.64	0.4628	1917	04.97	0.0326
1873	50.12	0.3283	1918	04.50	0.0295
1874	50.13	0.3284	1919	11.21	0.0734
1875	101.25	0.6633	1920	56.60	0.3708
1876	97.12	0.6362	1921	69.63	0.4561
1877	86.51	0.5667	1922	77.74	0.5093
1878	72.17	0.4728	1923	80.53	0.5275
1879	38.32	0.251	1924	73.38	0.4807
1880	10.11	0.0662	1925	36.93	0.2419
1881	07.74	0.0507	1926	04.64	0.0304
1882	09.67	0.0633	1927	02.54	0.0166
1883	43.12	0.2825	1928	01.80	0.0118
1884	52.21	0.342	1929	02.39	0.0157
1885	134.85	0.8834	1930	04.23	0.0277

1886	134.86	0.8835	1931	19.52	0.1279
1887	103.79	0.6799	1932	82.11	0.5379
1888	46.10	0.302	1933	89.76	0.588
1889	15.03	0.0985	1934	81.66	0.535
1890	24.20	0.1585	1935	15.76	0.1032

Table 3 is now referred to as 'df2' in the code, having the normalized values column with its corresponding year and population count. Using the values, we can rearrange the original logistic map equation to find the value of sensitivity for each year:

$$x_{n+1} = kx_n(1 - x_n)$$
$$x_{n+1}/(1 - x_n) = kx_n$$

$$\textcolor{red}{k = x_{n+1}/(1 - x_n)x_n}$$

Input Code 5: Calculating sensitivity (k value) using logistic map equation

```
#Calculating k values

df2['k'] = df2['Normalized_Hare'].shift(-1) / (df2['Normalized_Hare'] * (1 -
df2['Normalized_Hare']))

df2
```

Output Code 5:
Table 4: Updated table with corresponding year's k-value included.

Year	Hare	Normalized_Hare	K(Sensitivity)	Year	Hare	Normalized_Hare	K(Sensitivity)
1845	19.58	0.1283	1.1483	1891	41.65	0.2728	1.7282
1846	19.60	0.1284	1.1478	1892	52.34	0.3429	1.5636
1847	19.61	0.1285	0.7015	1893	53.78	0.3523	2.0210

1848	11.99	0.0785	2.5379	1894	70.40	0.4612	2.2622
1849	28.04	0.1837	2.5339	1895	85.81	0.5621	1.5088
1850	58.00	0.3800	2.0743	1896	56.69	0.3714	0.4655
1851	74.6	0.4887	1.9686	1897	16.59	0.1087	0.4166
1852	75.09	0.4919	2.3191	1898	06.16	0.0404	0.3890
1853	88.48	0.5796	1.6475	1899	02.30	0.0151	5.6591
1854	61.28	0.4014	2.0357	1900	12.82	0.0840	0.4019
1855	74.67	0.4892	2.3085	1901	04.72	0.0309	1.0340
1856	88.06	0.5769	1.8386	1902	04.73	0.0310	8.1205
1857	68.51	0.4488	0.8524	1903	37.22	0.2438	2.4771
1858	32.19	0.2109	0.4975	1904	69.72	0.4567	1.5254
1859	12.64	0.0828	1.8536	1905	57.78	0.3785	0.7987
1860	21.49	0.1408	1.6436	1906	28.68	0.1879	1.0034
1861	30.35	0.1988	0.08961	1907	23.37	0.1531	1.0883
1862	02.18	0.0143	69.0410	1908	21.54	0.1411	1.4237
1864	148.36	0.9719	20.5807	1909	26.34	0.1726	2.4363
1865	85.81	0.5621	1.1021	1910	53.1	0.3479	1.9775
1866	41.41	0.2713	0.4887	1911	68.48	0.4486	2.0016
1867	14.75	0.0966	0.1711	1912	75.58	0.4951	1.5178
1868	02.28	0.0149	2.6314	1913	57.92	0.3794	1.1398
1869	05.91	0.0387	1.7513	1914	40.97	0.2684	0.8324
1870	09.95	0.0652	1.1224	1915	24.95	0.1634	0.6032
1871	10.44	0.0684	7.2630	1916	12.59	0.0825	0.4302

1872	70.64	0.4628	1.3206	1917	04.97	0.0326	0.9359
1873	50.12	0.3283	1.4891	1918	04.5	0.0295	2.5668
1874	50.13	0.3284	3.0073	1919	11.21	0.0734	5.4492
1875	101.25	0.6633	2.8487	1920	56.6	0.3708	1.9551
1876	97.12	0.6362	2.4486	1921	69.63	0.4561	2.0529
1877	86.51	0.5667	1.92541	1922	77.74	0.5093	2.1109
1878	72.17	0.4728	1.0071	1923	80.53	0.5275	1.9286
1879	38.32	0.2510	0.3522	1924	73.38	0.4807	0.9691
1880	10.11	0.0662	0.8198	1925	36.93	0.2419	0.1657
1881	07.74	0.0507	1.3160	1926	04.64	0.0304	0.5646
1882	09.67	0.0633	4.7607	1927	02.54	0.0166	0.7206
1883	43.12	0.2825	1.6874	1928	01.8	0.0118	1.3436
1884	52.21	0.3420	3.9254	1929	02.39	0.0157	1.7980
1885	134.85	0.8834	8.5764	1930	04.23	0.0277	4.7462
1886	134.86	0.8835	6.6037	1931	19.52	0.1279	4.8232
1887	103.79	0.6799	1.3876	1932	82.11	0.5379	2.3656
1888	46.1	0.3020	0.4670	1933	89.76	0.588	2.2082
1889	15.03	0.0985	1.7859	1934	81.66	0.535	0.4150
1890	24.2	0.1585	2.0453	1935	15.76	0.1032	NaN

The sensitivity calculated for each year using the logistic map equation is added to the 'df2' variable as another column, as shown in Table 4. To gain visual insight of the data calculated, we can plot the (K) values (Figure 4):

Input Code 6: Plotting the k-values using Matplotlib library

```
#Plotting k values
import matplotlib.pyplot as plt
```
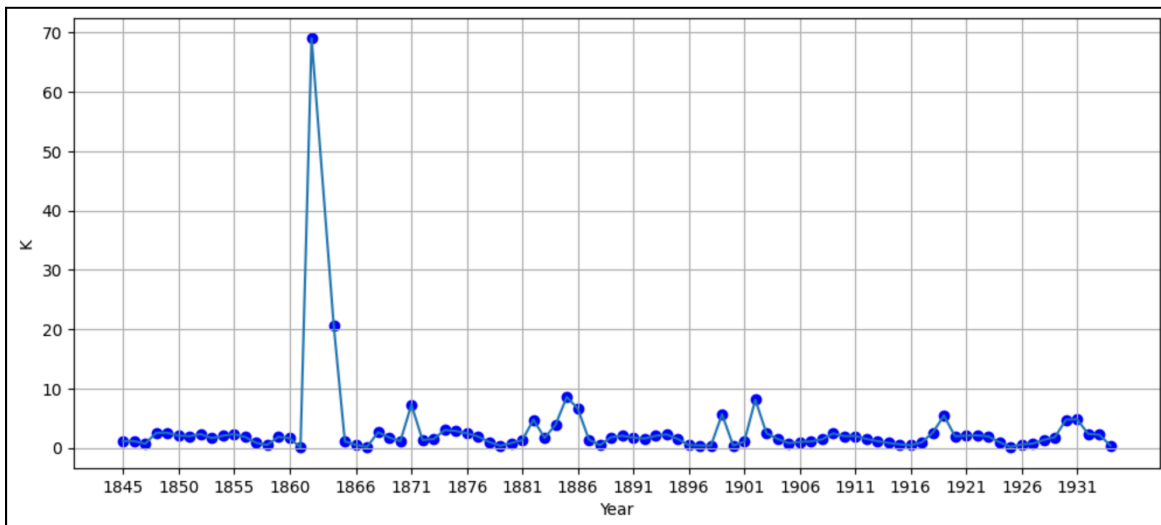
```
plt.figure(figsize=(12, 5))
plt.plot(df2.index, df2['k'])
plt.scatter(df2.index, df2['k'], color='blue')
plt.xlabel('Year')
plt.ylabel('K')
plt.grid(True)

plt.xticks(df2.index[::5])
plt.show()
```

Output Code 6:

Figure 4: Plot of sensitivity (K) calculated from the data. The graph represents the sensitivity values for each year (line plot and scatter plot). The values are the same as the ones provided in Table 4.

We can infer from Figure 4 that almost all sensitivity values are within the range of zero to ten. The abnormal peak value is only because of a sudden and drastic dip in the hare population in 1862. Since we have the (k) values for each year, let's recall Table 1. According to the logistic map equation, for sensitivities above ~3.56, we observe the completely chaotic nature of population growth.[4] This means the population neither stabilizes nor properly oscillates between a few values.

The analysis of real data and its comparison to the logistic map equation allow us to infer that the sensitivity of each year changes correctly. The (k) value doesn't remain constant, which is also what we observe in nature. The sensitivity is affected by the natural surroundings and activities.

Discussion

We can start by collecting a list of years where the (k) value was greater than 3.56. The shortlisted years and their respective sensitivity values are given in Table 5:

Input Code 7: Filtering out years with k > 3.56

```
#Collecting and storing data

limit = 3.56
filtered_data = df2[df2['k'] > limit]['k']

filtered_data
```

Output Code 7:

Table 5: New table of years (and their corresponding k-value) with k > 3.56.

Year	K(Sensitivity)
1862	69.04
1864	20.58
1871	7.26
1882	4.76
1884	3.92
1885	8.58
1886	6.60
1899	5.66
1902	8.12
1919	5.45
1930	4.75
1931	4.82

Since we have the sensitivity of the population for these years, we can make some important inferences through Table 5. These years have sensitivities, which do not allow the population to stabilize and reach equilibrium over many years. The high value of these sensitivities is observed

significantly in the year range from 1882 to 1886, suggesting high natural activities and high breeding among the population (since the sensitivity is more or less the growth factor for the population).

If we were to plot the graphs of any of these sensitivities using the population value for that corresponding year, we would get a graph with no underlying pattern, only random fluctuations. Therefore, the chaotic nature of population growth was there for these years. To gain visual insight, using the example of 1885 and 1862, The given graphs show what the population demography should have been if it were determined by the logistic map equation (Figure 5 and Figure 6):

Input Code 8: Plotting graph for the predicted population from 1885 using the corresponding calculated (k) value

```
import matplotlib.pyplot as plt

starting_year = 1885
num_years = 50
k = 8.85
populations = [0.8835]

for i in range(num_years-1):
    res = k*populations[-1]*(1-populations[-1])
    res = res % 1.0
    populations.append(res)print(populations)

years = list(range(starting_year, starting_year + num_years))

plt.figure(figsize=(10, 6))
plt.plot(years, populations, marker='o')
plt.xlabel('Year')
plt.ylabel('Population (in thousands)')
plt.title('Population Prediction Using Logistic Map Equation')
plt.grid(True)
plt.show()
```
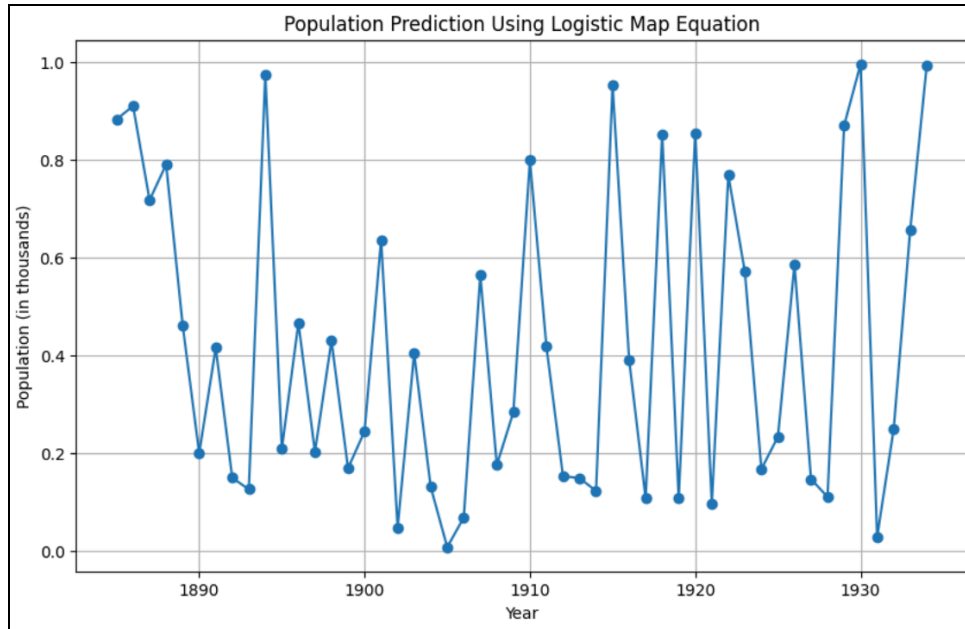
Output Code 8:

66

Figure 5: Predicted population changes from 1885 using the corresponding calculated (k) value of the logistic map equation**.** The graph shows the chaotic behavior for one of the years from Table 5. In this case, the year 1885 was chosen with k = 8.58. The figure is a graphical representation of population growth, with the value of (k) as 8.58. Clearly, the graph shows chaotic behavior with random fluctuations.

Input Code 9: Plotting graph for the predicted population from 1862 using the corresponding calculated (k) value

```
import matplotlib.pyplot as plt

starting_year = 1862
num_years = 50
k = 690.4
populations = [0.0143]

for i in range(num_years-1):
    res = k*populations[-1]*(1-populations[-1])
    res = res % 1.0
    populations.append(res)print(populations)

years = list(range(starting_year, starting_year + num_years))

plt.figure(figsize=(10, 6))
plt.plot(years, populations, marker='o')
plt.xlabel('Year')
```
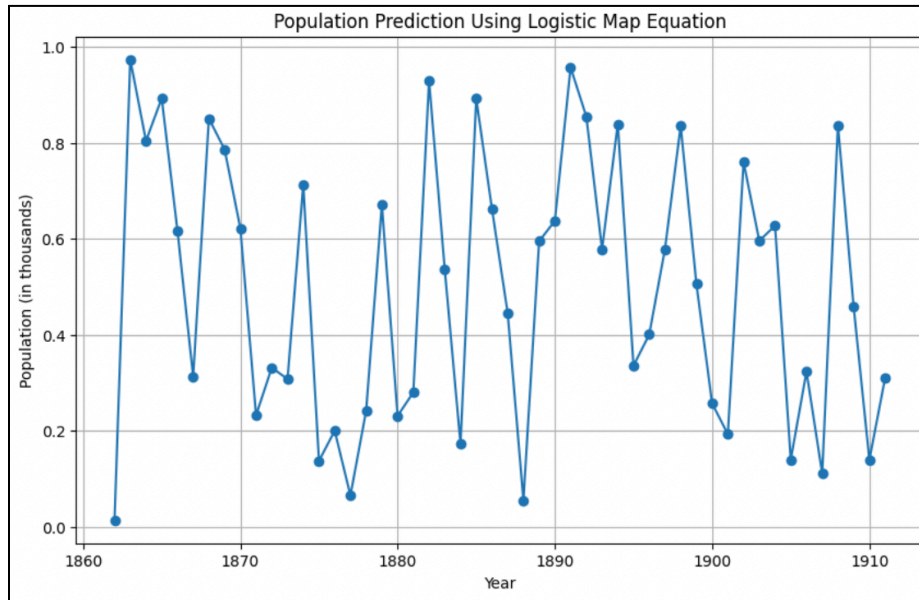
```
plt.ylabel('Population (in thousands)')
plt.title('Population Prediction Using Logistic Map Equation')
plt.grid(True)
plt.show()
```

Output Code 9:

Figure 6: Predicted population changes from 1862 using the corresponding calculated (k) value of the logistic map equation. Shows the chaotic behavior for one of the years in Table 5. In this case, the year 1862 was chosen with k = 69.04. The figure is a graphical representation of population growth, with the value of (k) as 69.04. Clearly, it shows chaotic behavior with random fluctuations.

If we were to compare it to Figure 3, we would notice a significant difference between the real natural population behavior and the behavior shown by the logistic map equation.

Even if nature were to follow the logistic map equation, the sensitivity cannot remain constant due to the multitude of factors that affect it.

Conclusion

In conclusion, we can infer that the rate of population change is different for different years for the snowshoe hare species. As expected and as Figure 3. suggests, the population shows frequent fluctuations, with spikes occurring every ten years or so.

The highest spikes were observed in the 1860s and 1880s when the sensitivity values were calculated to be in the chaotic range. This inference can allow us to conclude that high and sudden population spikes can indicate chaotic behavior, mainly influenced by natural conditions, situations, and surroundings.

However, as Figure 5. and Figure 6. suggest, the real-life data did not follow highly chaotic fluctuations shown by the logistic map equation. The reason for this is obvious; for every year, the sensitivity, or the (k) value differs, giving different populations because the natural surroundings are never consistent.

An important error identified towards the end of the calculation was the failure to normalize the population count before calculating the k-values using the logistic map equation. Consequently, the values obtained were unusual and significantly different from the true values calculated subsequently, resulting in misleading conclusions regarding the chaotic nature of the system. This minor error was identified and corrected.

Limitations

The dataset from GitHub[10-11] had the errors/uncertainty of the population measured; we could've also calculated the errors in the sensitivities. This could have increased the confidence of the values calculated while assessing the chaotic nature of the demography.

A more recent dataset for the population of snowshoe hares was not available.

Works Cited

1. Figueroa, W., Prada, D. A., Vera, P., Gómez, J. M. G., Montes, E., & Bautista, G. (2020). Analysis of population dynamics and chaos theory. *Journal of Physics*, *1448*(1), 012001. https://doi.org/10.1088/1742-6596/1448/1/012001

2. *Robert May Mathematics and Ecology*. (n.d.). https://www.merton.ox.ac.uk/sites/default/files/inline-files/Robert-May.pdf

3. Shaurya-Seam. (n.d.). *GitHub - Shaurya-Seam/Bifurcation_Diagram_Chaos: A simple Python code to visualize the bifurcation diagram in the logistic map equation*. GitHub. https://github.com/Shaurya-Seam/Bifurcation_Diagram_Chaos/tree/main

4. Adeleke, J. O. (2022). Analysis of logistic maps. *ResearchGate*. https://doi.org/10.13140/RG.2.2.27790.23367

5 - *The chaos avant-garde*. (n.d.). Google Books. https://books.google.co.in/books?hl=en&lr=&id=olJqDQAAQBAJ&oi=fnd&pg=PA91&dq=the+butterfly+effect&ots=_3FSnx077n&sig=sCZfjLksTppTyvNZCuejx5abwRA&redir_esc=y#v=onepage&q=the%20butterfly%20effect&f=false

6. Biswas, H., Hasan, M., & Kumar Bala, S. (2018). CHAOS THEORY AND ITS APPLICATIONS IN OUR REAL LIFE. *Barishal University Journal Part*, *1*(1&2), 123–140. https://bu.ac.bd/uploads/BUJ1V5I12/6.%20Hena%20Rani%20Biswas.pdf

7. Figueroa, W., Prada, D. A., Vera, P., Gómez, J. M. G., Montes, E., & Bautista, G. (2020b). Analysis of population dynamics and chaos theory. *Journal of Physics*, *1448*(1), 012001. https://doi.org/10.1088/1742-6596/1448/1/012001

8. *Snowshoe Hare*. (n.d.). CT.gov - Connecticut's Official State Website. https://portal.ct.gov/DEEP/Wildlife/Fact-Sheets/Snowshoe-Hare

9. *Untitled document*. (n.d.). https://jmahaffy.sdsu.edu/courses/f00/math122/labs/labj/q3v1.htm

10. *Notebook*. (n.d.). https://jckantor.github.io/CBE30338/02.05-Hare-and-Lynx-Population-Dynamics.html

11. *Snowshoe Population Data*. (n.d.). http://people.whitman.edu/~hundledr/courses/M250F03/LynxHare.txt

12. *pandas - Python Data Analysis Library*. (n.d.). https://pandas.pydata.org/

13. *Matplotlib — Visualization with Python*. (n.d.). https://matplotlib.org/

14. Matsuda, H., Ogita, N., Sasaki, A., & Sato, K. (1992). Statistical Mechanics of Population: The Lattice Lotka-Volterra model. *Progress of Theoretical and Experimental Physics*, *88*(6), 1035–1049. https://doi.org/10.1143/ptp/88.6.1035

Figures

1. The graph is a representation of the logistic map equation sensitivity (k) on the x-axis and the corresponding population value of stabilization on the y-axis. It shows the chaotic nature of the equation.

2. The image shows the derivation of Feigenbaum's Constant from the equation, which is the ratio of consecutive bifurcation lengths

3. The graph represents the snowshoe hare population for each year (line plot and scatter plot). The values are the same as the ones provided in Table 2

4. The graph represents the sensitivity values for each year (line plot and scatter plot). The values are the same as the ones provided in Table 4.

5. The graph shows the chaotic behavior for one of the years from Table 5. In this case, the year 1885 was chosen with k = 8.58. The figure is a graphical representation of population growth, with the value of (k) as 8.58. Clearly, the graph shows chaotic behavior with random fluctuations.

6. The graph shows the chaotic behavior for one of the years from Table 5. In this case, the year 1885 was chosen with k = 8.58. The figure is a graphical representation of population growth, with the value of (k) as 8.58. The graph shows chaotic behavior with random fluctuations.

Impact of COVID-19 on Adolescent Mental Health By Audrey Yoon

Abstract

While many studies are showing that Covid-19 has an impact on mental health, in this review paper I will examine the impact of three features of the pandemic: quarantine, online learning, and social media use on adolescent mental health, and will argue that the impact of the pandemic on young will thus be wide-reaching, affecting them for decades to come. I will begin by discussing how each factor was changed by the pandemic, and then outlining what is known about how each of these factors impacts the mental health of young people, either generally, or during the pandemic. I will end by highlighting how these mental health impacts might be long-lasting, emphasizing the importance of this research field from a public health perspective.

Introduction

There are 774,834,251 confirmed cases of COVID-19 as of March 3, 2024 (World Health Organization [WHO], WHO Coronavirus (COVID-19) Dashboard). COVID-19 is impacting everyone's day-to-day lives, affecting both their physical and mental health. There are also social changes that happened because of Covid. Some social changes during Covid were quarantine and online learning. There was also an increase in the usage of social media during Covid to stay connected with people (Aldrich). Even though Covid impacts everyone, there are unique impacts on adolescents. For example, Covid creates setbacks in social and emotional skills that are supposed to develop during adolescence (Volkin). Setbacks on social and emotional skills can make adolescents more susceptible to mental health disorders (WHO, Mental health of Adolescents). Globally, towards the end of 2021, 1 out of 7 adolescents experienced mental health conditions (WHO, Mental health of Adolescents). Knowing the effects of Covid on mental health can help create a better treatment for lessening mental health disorders in adolescents, so more research should be done on this topic. While there are many ways COVID-19 influenced mental health, this article will look at the long-term effects of quarantine, online learning, and the use of social media on adolescent mental health.

What is COVID-19?

Coronavirus-19, also known as COVID-19, is a virus first identified in Wuhan, China in December 2019 which later morphed into a pandemic (Centers for Disease Control and Prevention [CDC], CDC Museum COVID-19). It was caused by Sars-CoV-2 coronavirus (Foucher and Faure) and has affected millions of people and continues to affect people to this day. Early on in the pandemic, people all over the world took several steps to stop the transmission of this virus because of the high infection rates. There was also no vaccine available for the Covid until December 2020 (Tanne). Now, there are multiple types of vaccines for the Covid including booster shots. In this article, COVID-19 will be referred to as Covid.

What is Adolescent Mental Health?

Adolescence is a period during the ages of 10 to 19 when a significant development occurs in the body and the brain (WHO, Adolescent health). According to the CDC, mental health is the well-being of emotional, psychological, and social health (CDC, About Mental Health). Adolescent mental health is the mental well-being of adolescents. In this article, teens are also used to describe adolescents.

Covid's Impact on Mental Health

Covid has had many effects on mental health. Higher levels of post-traumatic stress (Bo et. al.) and lower levels of psychological well-being were found (Sønderskov et. al.) during the pandemic. Also, psychiatric disorders worsened during this time (Fernández‑Aranda et. al.; Zhou et. al.). The most common psychiatric disorders that increased during Covid were depression and anxiety; there was a 27.6% increase in cases of major depressive disorders and a 25.6% increase in cases of anxiety disorders in the general population globally between January 2020 through January 2021 (Santomauro et. al.). People who have Covid have a higher risk for depression (Zhang et. al.). Being away from family, having poor health, unknown dangers, and having no vaccine can potentially increase the risk for depression and anxiety. However, symptoms of anxiety and depression declined over time to align similarly to pre-pandemic levels (as reviewed in Daly and Robinson). Although the symptoms have become less severe, the symptoms are still a big problem as they can leave negative long-term effects on a person's mental health. For example, in a study conducted by Poletti, the researchers examined the negative long-term effects Covid has on cognitive function (Poletti et. al.). The study shows that cognitive impairment, that was caused by Covid, has an association with depression, which causes harm to a person's quality of life. This suggests that negative mental health can impact the overall quality of life in people.

General Information about Covid's Impact on Adolescents' Mental Health

Adolescents are also impacted by Covid and the most common mental health disorders during Covid are depression and anxiety. In a study with 1036 participants that was conducted during the pandemic, about 36% of adolescents had depression, anxiety, or both (Chen et. al.). Older adolescents, between 13-15 years old, showed a higher risk for depression than younger people, who were between 6-12 years old (Chen et. al.). This can be because adolescence is a time when teens are more sensitive to peer social influence and a sudden change in the environment can harm their mental health. Also, during adolescence, the limbic system is more developed than the prefrontal cortex, making adolescents more sensitive to emotional responses (Konrad et. al.). Going to school and hanging out with friends is a big part of teens' lives, and not being able to do these things can increase the risk of getting depression. Anxiety levels were also higher in adolescents between the age of 13-15 during the pandemic (Chen et. al.).

Quarantine

Effects of Quarantine on General Population on Mental Health

Quarantine is the act of isolating people who have the disease from those who do not have the disease (CTC, Quarantine and Isolation). This is to prevent people from getting infected and stop the spread of the disease. It was effective during Covid, but it also came with mental health problems.

A study by Gan shows that public lockdown is associated with depression, and personal quarantine is associated with anxiety for everyone above junior high school education during Covid (Gan et. al.). Similarly, another study finds that quarantine increases levels of anxiety and stress in people regardless of Covid exposure (as reviewed in Jin et. al.). The unknown duration of the pandemic and worry for family members who have Covid can increase levels of anxiety and stress for everyone. Additionally, quarantine also disrupts everyday life and increases the risk of depression (De Lima et. al.). A sudden change in people's lifestyle can bring a burden on a person's mental health, which would lead to mental health disorders.

Alternatively, a study conducted 4 weeks after the initial outbreak found that quarantine did not have any connections to mental health disorders in people living in China (Wang et. al., Mental Health). However, 4 weeks may have not been long enough for the impacts of the pandemic to be realized. On the other hand, there were many studies conducted a couple of months into the pandemic that proved quarantine did affect mental health (as reviewed in Jin et. al.). Therefore, studies show that quarantine does indeed have an impact on mental health which appears to have taken several weeks to have been realized.

Effects of Quarantine on Adolescents' Mental Health

Specifically in adolescence, there was a greater chance of getting depression, anxiety, and feelings of loneliness during Covid (WHO, Pandemic Triggers; Christiansen et. al.). One study during Covid showed loneliness was associated with increased odds of long-term mental illness, depressive symptomatology, anxiety symptomatology, and alcohol problems (Christiansen et. al.). Loneliness is a feeling many people have during Covid and in adolescence, it causes disorders that are very detrimental to teens' mental health. A systematic review looked at the correlation between mental disorders and loneliness caused by quarantine and discovered a large association between depression and anxiety with loneliness (Loades et. al.). Increased odds of long-term mental illness, depressive symptomatology, and anxiety symptomatology are directly connected to social isolation and loneliness (Christiansen et. al.).

Overall, many studies show that loneliness is prominent during Covid due to quarantine; and loneliness causes mental health disorders, making quarantine one of the root causes for mental health disorders in teens.

In addition, there is an extensive amount of literature talking about how adolescence is a sensitive period for social connection (WHO, Mental health of Adolescents; Volkin; Brown et.

al.). Not being around friends can cause mental disorders and loneliness in teens. Also with teens, friends are a very important part of shaping their own identity (Brown et. al.). Since quarantine prohibits adolescents from engaging with one another typically, usually physically, people can expect that social isolation will affect social connections in teens. It is especially easy to feel excluded and lose friendships, which in turn, could easily cause depression (Beck and Clark).

Quarantine measures had a profound impact on children and adolescents. Worry, helplessness, and fear were indeed prevalent emotions during this time (Saurabh and Ranjan). Most of the feelings were caused by financial struggles, which were seen by the unavailability of basic needs in the household due to the loss of income or job (Saurabh and Ranjan). Although most of the feelings were caused by financial struggles, the potential of catching Covid also caused these feelings since children and adolescents would stay away from people who were sick or showing symptoms of Covid (Saurabh and Ranjan). Since teens under quarantine are more susceptible to mental health disorders (Saurabh and Ranjan), it can be hypothesized that if feelings of worry, helplessness, and fear get too overwhelming and happen often, it can lead to mental health disorders. This study also confirms the idea that teenagers and children who are less likely to interact in person can negatively impact their mental health more than teenagers and children who do interact in person regularly (Saurabh and Ranjan).

Even with all of the negative impacts, there are positive impacts of quarantine. An increase in discussion time with parents during Covid due to prolonged quarantine created a protective factor for mental health disorders (Tang et. al.). This suggests that quarantine provides a protective factor for adolescent mental health because quarantine increases bonding time for parents to talk to their kids.

Online Learning

Effect of Online Learning in General
Online learning was used as an alternative way to learn/go to school virtually during Covid as people could not physically attend schools. There were many self-reported cases of depression among university students (Wang et. al., Immediate Psychological Responses) because of the uncertainty and risks of the pandemic (as reviewed in Akpınar). High schoolers reported feelings of sadness and hopelessness during Covid because of the sudden halt of activities, like school and extracurriculars (Hertz et. al.). On the contrary, there were reports of online learning being beneficial to students, like helping students learn at a faster rate; however, other people argue that stress levels increased (as reviewed in Akpınar). Stress plays a big part in people's mental health as it affects their concentration and many other cognitive functions. In this case, stress affects the students' ability to focus on the lecture and understand the concept (Akpınar). Mental health was further damaged by the missing support from school counselors as there was no "push" to talk about the students' hardships, making the students hold all of their negative thoughts inside with no help (Akpınar).

Effects of Online Learning on Adolescents' Mental Health

Covid has brought many negative effects on adolescent mental health and online learning played a big role. Students who had online education experienced higher levels of stress, depressive symptoms, and impaired mental health compared to those who had hybrid or in-person learning experiences (Hertz et. al.). There was an increase in self-harm, suicidal thoughts, and suicide (Hertz et. al.). There might be several factors playing into the increase in self-harm and suicide, but online learning is one of the main factors as it increases stress and damages mental health. In addition, many things were taken away from adolescents as a result of online learning. For example, a relationship with a teacher with online-only interaction might differ from a student who meets them physically every day. There was also a low social connection among students doing online learning (Hertz et. al.). This can lower the sense of involvement and belonging that is very important for adolescent mental health.

Not having an individual computer and sharing a room with others (Rzanova et. al.) during online learning sessions are challenges that people might have not thought about during an in-person school environment. New distractions, increased homework, and experiencing different teaching platforms gave teens anxiety about their grades (Rzanova et. al.). However, about half of the students stated that online learning did not harm their grades and felt that their teachers were more understanding (Rzanova et. al.). Even so, anxiety from school on top of anxiety caused by Covid could damage teens' mental health.

Even with all of the negative effects of online learning on mental health, with higher distance learning support, there was an improvement in mental health, grit, self-efficacy, and decreased perceived stress in teens (Kwaning et. al.). Higher distance learning support includes positive family functions and trusted communication with teachers and school staff (Kwaning et. al.). There was also less risk of doing risky behaviors like drugs and delinquency because the students were at home constantly (Kwaning et. al.).

Social Media Use

Effect of Social Media Use in General

Social media usage, which is one of the technologies that people use the most, went up by 70 percent during 2020 (Aldrich) which coincided with the onset of Covid lockdowns. The increase in time spent online, especially on social media, affects a person's mental health.

There are both pros and cons to social media use during Covid. Some of the benefits are that it gives access to lots of information, shows the latest evidence, and allows people from all around the world to collaborate on the latest findings on Covid (Venegas-Vera et. al.).

Some cons of social media are that there is overwhelming evidence of misinformation about Covid that is spread through social media (Brennen et. al.), which is associated with greater confusion regarding the truth about Covid (Venegas-Vera et. al.). The flow of information can also be affected because people tend to look at posts that support their beliefs (Brennen et. al.). This can be harmful as people can be biased toward a certain idea that they believe in about Covid that might not be correct.

Effect of Social Media Use on Adolescents' Mental Health

Many adolescents are using social media more because of Covid and they use it to talk and connect with their friends (Hamilton et. al.). Talking to friends through social media can improve mental health by having personal interactions. Social media is also a great way for teens to express their creativity and help them know more about themselves by posting their creative works (Davis and Weinstein). During the pandemic, social media helped teens be more creative and bring joy into their lives.

However, social media can negatively impact teens' view of their image (Hamilton et. al.), making them more insecure. Posts about models, celebrities, and other influencers can negatively affect adolescents' anxiety levels by making them think they need to be and act in a certain "way" (as reviewed in Hamilton et. al.). Many studies show that social media usage has a connection to higher levels of depression, body dissatisfaction, eating disorders, and risky behaviors (Holland and Tiggemann; Vannucci et. al.). With more time spent on social media, it can create a sense of hopelessness and negativity (Hamilton et. al.).

Lots of information on social media can overwhelm and intensify feelings of depression and anxiety (Cauberghe et. al.). A study found that social media was related to depression, anxiety, low self-esteem, and other mental disorders in teens (Magson et. al.). There was also an increase in distress among teens who used social media for over three hours before Covid (Rens et. al.). Since adolescents spent 5-10 hours per day on social media during Covid (as reviewed in Marciano et. al.), it is suspected to be an increase in distress in teens' mental health. Some people state they use social media to feel less anxious (Cauberghe et. al.); however, other people feel overwhelmed by all of the information on social media (Islam et. al.).

Discussion

With all of the evidence shown in this research, it is clear that quarantine, online learning, and social media use all have both positive and negative effects on adolescent mental health. For the positives, quarantine provided protective factors against mental health disorders (Tang et. al.), online learning helped adolescents learn information faster (Akpınar), and social media helped teens express their creativity (Davis and Weinstein) during Covid.

For negative effects, quarantine, online learning, and social media all increased depression and anxiety symptoms, as well as intensified the feeling of less satisfaction of life in teens (Magson et. al.). There are specific effects with quarantine increasing loneliness (Loades et. al.), online learning increasing self-harm and suicidal thoughts (Hertz et. al.), and social media lowering self-esteem (Magson et. al.). Even though there are positive effects, people should focus more on the negative effects because there are more negative impacts Covid has on adolescent mental health than the positive impacts.

Implications

Quarantine undoubtedly negatively affects mental health. Even though quarantine is a safe way to prevent people from transmitting the disease through the air (CTC, Quarantine and Isolation), we cannot ignore all of the increased risks of mental health disorders in adolescents (Christiansen et. al.; Saurabh and Ranjan). People have to understand more about the relationship between quarantine and mental health to help people recover from the disorders they might have gotten from Covid. People can also use the information to find better ways to stop the transmission of the disease without increasing the risk of developing a mental health disorder.

Online learning also plays a big role in adolescent mental health. Although some people might say that online learning has a positive effect on mental health, it needs to be assisted with higher support. Providing higher online learning support can be hard as some people have never experienced online learning before. Higher support can have positive effects, but right now there is not a lot of support, making online learning challenging to adolescent mental health.

Social media can have both a positive and negative effect on adolescent mental health. A teen's experience with social media can vary depending on their usage, but the cons outweigh the pros. There might be better ways for teens to contact their friends without using social media. FaceTime might be better than social media because teens can see their friend's faces and have fewer distractions from things like posts that are found on social media apps.

Limitations and Future Directions

There are only a handful of articles that talk about the long-term effects of Covid on mental health. One study by Kaltschik talked about the long-term effects of Covid; it stated that there continues to be a decrease in adolescent mental health even though the restrictions were removed (Kaltschik et. al.). This supports the idea that there are negative long-term effects and more research has to be done to be more up-to-date with what is happening to adolescent mental health. One idea is to compare the types of mental health conditions in adolescents before and throughout Covid. From the information gathered, people could assume what would happen in the future based on the trend and understand more about the effect of Covid on adolescent mental health. This can help provide a treatment that is best suited to the current situation of mental disorders in adolescents.

Although it was outside the scope of this review, it is also worth considering the role that gender plays in the impacts of Covid on adolescent mental health. For example, females are more susceptible to mental disorders than males during Covid (Magson et. al.). Further study on why females have a higher risk of getting a mental disorder when both genders experienced Covid can help people learn more about mental health for each gender. Therapists could offer better treatment options for each gender based on this information, so future studies should consider researching the relationship that gender plays on adolescent mental health.

Conclusion

Covid is a period that people cannot forget. Plenty of evidence shows that Covid has negatively affected people's mental health. There are numerous reasons why adolescent mental

health during Covid is an important topic to study. Specifically, the mental health of adolescents affects the development of their body and the brain (Kieling et. al.), suggesting that negative mental health can have harmful effects on their development. Another reason is how an early onset of mental health problems is associated with the duration of the mental disorder (Scott et. al.). Adolescence is a critical part of our lives and looking into the long-term effect of Covid will be beneficial to treating mental health disorders for all ages.

Works Cited

Akpınar, Ezgin. "The effect of online learning on tertiary level students mental health during the COVID-19 lockdown." *The European Journal of Social & Behavioural Sciences*, 1 Dec. 2021, https://www.europeanpublisher.com/en/article/10.15405/ejsbs.288.

Aldrich, Anna Zarra. "Finding Social Support Through Social Media During COVID Lockdowns." *UConn Today*, 24 June 2022, https://today.uconn.edu/2022/06/finding-social-support-through-social-media-during-covid-lockdowns/#:~:text=During%20the%20first%20wave%20in,same%20from%20the%20first%20wave.

Beck, Aaron T., and David A. Clark. "Anxiety and depression: An information processing perspective." *Anxiety and Self-focused Attention*, 2015, https://www.taylorfrancis.com/chapters/edit/10.4324/9781315674766-7/anxiety-depression-information-processing-perspective-aaron-beck-david-clark. Accessed 24 Mar. 2024.

Bo, Hai-Xin, et. al. "Posttraumatic stress symptoms and attitude toward crisis mental health services among clinically stable patients with COVID-19 in China." *Psychological medicine*, 27 Mar. 2020, https://www.cambridge.org/core/journals/psychological-medicine/article/posttraumatic-stress-symptoms-and-attitude-toward-crisis-mental-health-services-among-clinically-stable-patients-with-covid19-in-china/32D66826C54EB1A96C008089C0DE500E.

Brennen, J. Scott, et. al. "Types, sources, and claims of COVID-19 misinformation." *University of Oxford*, 2020, https://ora.ox.ac.uk/objects/uuid:178db677-fa8b-491d-beda-4bacdc9d7069. Accessed 24 Mar. 2024.

Brown, B. Bradford, Sue Ann Eicher, and Sandra Petrie. "The importance of peer group ("crowd") affiliation in adolescence." *Journal of adolescence,* March 1986, https://onlinelibrary.wiley.com/doi/abs/10.1016/S0140-1971(86)80029-X. Accessed 24 Mar. 2024.

Cauberghe, Verolien, et. al. "How adolescents use social media to cope with feelings of loneliness and anxiety during COVID-19 lockdown." *Cyberpsychology, behavior, and social networking*, 9 Apr. 2021, https://www.liebertpub.com/doi/10.1089/cyber.2020.0478.

Centers for Disease Control and Prevention. "About Mental Health." *Centers for Disease Control and Prevention*, 25 Apr. 2023, https://www.cdc.gov/mentalhealth/learn/index.htm.

Centers for Disease Control and Prevention. "CDC Museum COVID-19 Timeline." *Centers for Disease Control and Prevention*, 15 Mar. 2023, https://www.cdc.gov/museum/timeline/covid19.html#:~:text=December%2012%2C%202019,respond%20well%20to%20standard%20treatments.

Centers for Disease Control and Prevention. "Quarantine and Isolation." *Centers for Disease Control and Prevention*, 29 Sep. 2017, https://www.cdc.gov/quarantine/index.html.

Chen, Fangping, et. al. "Depression and anxiety among adolescents during COVID-19: A cross-sectional study." *Brain, Behavior, and Immunity*, 12 May 2020, https://www.sciencedirect.com/science/article/pii/S0889159120308916?via%3Dihub.

Christiansen, Julie, et. al. "Associations of loneliness and social isolation with physical and mental health among adolescents and young adults." *Perspectives in Public Health*, 19 June 2021, https://journals.sagepub.com/doi/10.1177/17579139211016077.

Daly, Michael, and Eric Robinson. "Depression and anxiety during COVID-19." *The Lancet,* 5 Feb. 2022, https://www.researchgate.net/publication/358684013_Depression_and_anxiety_during_COVID-19.

Davis, Katie, and Emily Weinstein. "Identity development in the digital age: An Eriksonian perspective." *IGI Global*, 2017, https://www.igi-global.com/chapter/identity-development-in-the-digital-age/173150. Accessed 24 Mar. 2024.

De Lima, Carlos Victor Chaves, et. al. "Effects of quarantine on mental health of populations affected by Covid-19." *Journal of Affective Disorders,* 15 July 2020, https://www.sciencedirect.com/science/article/pii/S0165032720324605.

Foucher, Gérard, and Sébastien Faure. "What is Covid-19?" *Actualités Pharmaceutiques*, 2020, https://www.sciencedirect.com/science/article/pii/S0515370020304456. Accessed 24 Mar. 2024.

Fernández‑Aranda, Fernando, et. al. "COVID‑19 and implications for eating disorders." *European Eating Disorders Review*, 28 Apr. 2020, https://onlinelibrary.wiley.com/doi/10.1002/erv.2738.

Gan, Yiqun, et. al. "Immediate and delayed psychological effects of province-wide lockdown and personal quarantine during the COVID-19 outbreak in China." *Psychological medicine,* 13 Aug. 2020, https://www.cambridge.org/core/journals/psychological-medicine/article/immediate-and-delayed-psychological-effects-of-provincewide-lockdown-and-personal-quarantine-during-the-covid19-outbreak-in-china/69A7E798EA2214ACB04BEB526A9B4740.

Hamilton, Jessica L., Jacqueline Nesi, and Sophia Choukas-Bradley. "Teens and social media during the COVID-19 pandemic: Staying socially connected while physically distant." *OSF*, 29 Sep. 2020, https://osf.io/preprints/psyarxiv/5stx4.

Hertz, Marci F., et. al. "Adolescent mental health, connectedness, and mode of school instruction during COVID-19." *Journal of Adolescent Health,* 21 Oct. 2021, https://www.jahonline.org/article/S1054-139X(21)00550-4/fulltext.

Holland, Grace, and Marika Tiggemann. "A systematic review of the impact of the use of social networking sites on body image and disordered eating outcomes." *Body Image*, 29 Feb. 2016, https://www.sciencedirect.com/science/article/abs/pii/S1740144516300912.

Islam, AKM Najmul, et. al. "Misinformation sharing and social media fatigue during COVID-19: An affordance and cognitive load perspective." *Technological Forecasting*

and Social Change, 6 July 2020,
https://www.sciencedirect.com/science/article/pii/S0040162520310271?via%3Dihub.

Jin, Yuchang, et. al. "Mass quarantine and mental health during COVID-19: A meta-analysis."
Journal of Affective Disorders, 25 Aug. 2021,
https://www.sciencedirect.com/science/article/pii/S0165032721008727.

Kaltschik, Stefan, et. al. "Assessment of the long-term mental health effects on Austrian students
after COVID-19 restrictions." *International Journal of Environmental Research and
Public Health*, 12 Oct. 2022, https://www.mdpi.com/1660-4601/19/20/13110.

Kieling, Christian, et. al. "Child and adolescent mental health worldwide: evidence for action."
The Lancet, 22 Oct. 2011,
https://www.sciencedirect.com/science/article/abs/pii/S0140673611608271.

Konrad, Kerstin, Christine Firk, and Peter J. Uhlhaas. "Brain development during adolescence:
neuroscientific insights into this developmental period." *Deutsches Ärzteblatt
International,* 7 Aug. 2012, https://www.aerzteblatt.de/int/archive/article/141135.

Kwaning, Karen, et. al. "Adolescent feelings on COVID-19 distance learning support:
associations with mental health, social-emotional health, substance use, and
delinquency." *Journal of Adolescent Health*, 16 Jan. 2023,
https://www.jahonline.org/article/S1054-139X(22)01046-1/fulltext.

Loades, Maria Elizabeth, et. al. "Rapid systematic review: the impact of social isolation and
loneliness on the mental health of children and adolescents in the context of COVID-19."
Journal of the American Academy of Child & Adolescent Psychiatry, 2 June 2020,
https://www.jaacap.org/article/S0890-8567(20)30337-3/fulltext.

Magson, Natasha R., et. al. "Risk and protective factors for prospective changes in adolescent
mental health during the COVID-19 pandemic." *Journal of Youth and Adolescence,* 27
Oct. 2020, https://link.springer.com/article/10.1007/s10964-020-01332-9.

Marciano, Laura, Michelle Ostroumova, and Anne-Linda Camerini. "Digital media use and
adolescents' mental health during the COVID-19 pandemic: a systematic review and
meta-analysis." *Frontiers in Public Health,* 31 Jan. 2022,
https://www.frontiersin.org/journals/public-health/articles/10.3389/fpubh.2021.793868/fu
ll.

Martin, Erika G., and Lucy C. Sorensen. "Protecting the health of vulnerable children and
adolescents during COVID-19–related K-12 school closures in the US." *JAMA Health
Forum*, 16 June 2020,
https://jamanetwork.com/journals/jama-health-forum/fullarticle/2767411.

Poletti, Sara, et. al. "Long-term consequences of COVID-19 on cognitive functioning up to 6
months after discharge: role of depression and impact on quality of life." *European
Archives of Psychiatry and Clinical Neuroscience,* 26 Oct. 2021,
https://link.springer.com/article/10.1007/s00406-021-01346-9.

Rens, Eva, et. al. "Mental distress and its contributing factors among young people during the
first wave of COVID-19: a Belgian survey study." *Frontiers in Psychiatry*, 27 Jan. 2021,

https://www.frontiersin.org/journals/psychiatry/articles/10.3389/fpsyt.2021.575553/full.

Rzanova, Svetlana, et. al. "Distance learning challenges and prospects during Covid-19 in the
context of adolescent education." *Social Work in Mental Health*, 24 Mar. 2022,
https://www.tandfonline.com/doi/full/10.1080/15332985.2022.2055439.

Santomauro, Damian F., et. al. "Global prevalence and burden of depressive and anxiety
disorders in 204 countries and territories in 2020 due to the COVID-19 pandemic." *The
Lancet,* 8 Oct. 2021,
https://www.thelancet.com/journals/lancet/article/PIIS0140-6736(21)02143-7/fulltext.

Saurabh, Kumar, and Shilpi Ranjan. "Compliance and psychological impact of quarantine in
children and adolescents due to Covid-19 pandemic." *The Indian Journal of Pediatrics*,
29 May 2020, https://link.springer.com/article/10.1007/s12098-020-03347-3.

Scott, Kate M., et. al. "Association of childhood adversities and early-onset mental disorders
with adult-onset chronic physical conditions." *Archives of General Psychiatry*, Aug.
2011, https://jamanetwork.com/journals/jamapsychiatry/fullarticle/1107420. Accessed 24
Mar. 2024.

Sønderskov, Kim Mannemar, et. al. "The depressive state of Denmark during the COVID-19
pandemic." *Acta Neuropsychiatrica*, 22 Apr. 2020,
https://www.cambridge.org/core/journals/acta-neuropsychiatrica/article/depressive-state-
of-denmark-during-the-covid19-pandemic/14CD9360B18C683A3D22C1BFA4764B45.

Tang, Suqin, et. al. "Mental health and its correlates among children and adolescents during
COVID-19 school closure: The importance of parent-child discussion." *Journal of
Affective Disorders*, 7 Oct. 2020,
https://www.sciencedirect.com/science/article/pii/S0165032720328603.

Tanne, Janice Hopkins. "Covid-19: FDA approves Pfizer-BioNTech vaccine in record time." *The
BMJ,* 24 Aug. 2021, https://www.bmj.com/content/374/bmj.n2096.short.

Vannucci, Anna, et. al. "Social media use and risky behaviors in adolescents: A meta-analysis."
Journal of Adolescence, 1 Feb. 2020,
https://onlinelibrary.wiley.com/doi/10.1016/j.adolescence.2020.01.014.

Venegas-Vera, A. Verner, Gates B. Colbert, and Edgar V. Lerma. "Positive and negative impact
of social media in the COVID-19 era." *Reviews in Cardiovascular Medicine*, 30 Dec.
2020, https://www.imrpress.com/journal/RCM/21/4/10.31083/j.rcm.2020.04.195.

Volkin, Samuel. "The Impact of the Covid-19 Pandemic on Adolescents." *Johns Hopkins
University Hub,* 11 May 2020, https://hub.jhu.edu/2020/05/11/covid-19-and-adolescents/.

Wang, Cuiyan, et. al. "Immediate psychological responses and associated factors during the
initial stage of the 2019 coronavirus disease (COVID-19) epidemic among the general
population in China." *International Journal of Environmental Research and Public
Health*, 6 Mar. 2020, https://www.mdpi.com/1660-4601/17/5/1729.

Wang, Cuiyan, et. al. "A longitudinal study on the mental health of general population during the
COVID-19 epidemic in China." *Brain, Behavior, and Immunity,* 10 Apr. 2020,
https://www.sciencedirect.com/science/article/pii/S0889159120305110.

World Health Organization. "WHO Coronavirus (COVID-19) Dashboard." *World Health Organization*, 3 Mar. 2024, https://data.who.int/dashboards/covid19/cases?n=c.

World Health Organization. "COVID-19 pandemic triggers 25% increase in prevalence of anxiety and depression worldwide." *World Health Organization*, 2 Mar. 2022, https://www.who.int/news/item/02-03-2022-covid-19-pandemic-triggers-25-increase-in-p revalence-of-anxiety-and-depression-worldwide.

World Health Organization. "Mental health of Adolescents." *World Health Organization*, 17 Nov. 2021, https://www.who.int/news-room/fact-sheets/detail/adolescent-mental-health#:~:text=Phys ical%2C%20emotional%20and%20social%20changes,vulnerable%20to%20mental%20h ealth%20problems.

World Health Organization. "Adolescent health." *World Health Organization*, https://www.who.int/health-topics/adolescent-health#tab=tab_1. Accessed 24 Mar. 2024.

Zhang, Jie, et. al. "The differential psychological distress of populations affected by the COVID-19 pandemic." *Brain, Behavior, and Immunity*, 12 Apr. 2020, https://www.sciencedirect.com/science/article/pii/S0889159120305353?via%3Dihub.

Zhou, Junying, et. al. "Mental health response to the COVID-19 outbreak in China." *American Journal of Psychiatry,* 7 May 2020, https://ajp.psychiatryonline.org/doi/10.1176/appi.ajp.2020.20030304.

Should we use empathy for ethical decision-making? By Mari Abey

Introduction

In the paper titled "Motivating Empathy" by Shannon Spaulding, an Associate Professor of Philosophy at Oklahoma State University, the strongest argument against empathy as a basis for making ethical decisions is that empathy is motivated. To state that empathy is motivated means that our subjective desires and interests drive us to use empathy. Many adverse outcomes usually lead this motivation to ethical complications, such as selfishness and self-interested behaviors or thoughts. According to this line of reasoning, if empathy is driven by motivation, its utilization would be influenced by factors unrelated to moral consideration.

In this essay, I will argue - contra Spaulding - that we should use empathy in ethical decision-making. My argument will have three components. First, I will say that without empathy, we miss out on morally relevant information that is not otherwise available. Second, I am going to argue that empathy is not itself motivated. Instead, empathy and motivation are separate phenomena. Third, although it is true that without conscious effort, moral agents may be motivated to deploy empathy selectively and for the wrong reasons, we can counteract this problem through moral training. I suggest that we think of empathy as a moral virtue. Virtue ethics requires us to develop the skill to deploy our moral facilities in the right situations by consciously making an effort to learn to recognize the conditions in which we should deploy empathy (in order to access morally relevant information); we can take conscious control of motivation and use empathy in the proper contexts. Because we would only benefit from essential and morally relevant information with empathy, the motivation problem does not show that we should not use empathy for moral decision-making; it only indicates that we should practice empathy as a virtue, consciously controlling motivation.

In this paper, I will first summarize Shannon Spaulding's argument in her report titled "Motivating Empathy." I will then analyze her view by discussing what it truly means to state that empathy is motivated and if it can be held logically and with validity. Next, I will argue that
empathy is needed when making ethical decisions. To conclude, I will refute
other counterarguments that can be made against my claim.

Intuitive Case for Empathy

In this section, I will explain why empathy is an essential tool humans should use. There is a prima facie case to think empathy provides morally relevant information.

What is Empathy?

Empathy is understanding and sharing another person's feelings, perspectives, and experiences. It involves putting oneself in another person's shoes and feeling what they feel (Batson and Shaw). Empathy provides us with morally relevant information that is not accessible through any other psychological mechanism. Empathy often involves sharing the

emotional experiences of others. On the other hand, different emotions, such as sympathy or compassion, might include feeling sorry for someone; empathy goes further by allowing you to handle some of the feelings that someone might be experiencing (Spiro). Moral imagination allows you to anticipate the consequences of different actions and assess ethical implications from the perspective of the affected individuals. For example, if you are arguing with a close friend, an easier way to argue your perspective and resolve the fight is to try to observe from their perspective. It allows you to see from someone else's viewpoint, which can help benefit both parties (Nortje).

Philosophers have grappled with the concept of empathy, attempting to find its significance within the human experience. At its core, philosophers often define empathy as an emotional response to the emotions or circumstances of another individual that closely mirrors, to an extent, what that person is feeling or is anticipated to feel (Maibon). This intricate interplay of emotions forms a bridge between individuals, enabling a deeper understanding of one another's subjective states.

The philosophical interpretation of empathy is the idea that it involves not only recognizing another person's emotional state but also being attuned to the underlying factors that contribute to those feelings. This extends beyond mere surface-level identification and requires certain degrees of emotional resonance, allowing one to connect with the experiences of another genuinely. This shared emotional terrain forms the foundation for meaningful human interactions.

Summary of Spaulding's Argument

In this section of my paper, I will reconstruct Spaulding's argument in her paper, "Motivating Empathy." I will address the key points and opinions that she argues in her paper. As stated above, Spaulding's most potent argument against empathy as a basis for making moral decisions in Spaulding's paper is that empathy is motivated, which means that we use our biased desires as momentum for making unethical decisions. To express that empathy is motivated is to say that empathy usually leads to many adverse outcomes and ethical complications, such as self-interested behaviors or thoughts. While selfishness may not inherently be deemed immoral, empathy inclines one toward prioritizing one's interests above those of others. The underlying argument suggests that if empathy is driven by motivation, this could pose a predicament, as the utilization of empathy might then be contingent upon factors devoid of moral significance.

I will now explain Spaulding's reasons for each premise and why they sound plausible. She first argues that Empathy is motivated. There is an "interpersonal and intrapersonal variation concerning when, where, and with whom we empathize" (Spaulding). When we "choose" to empathize, we are mainly driven by our own personal wants, needs, and goals (Zaki). If it is well known that when we empathize, it will lead to a positive outcome for ourselves, we are more likely to empathize, and vice versa. As an illustration, consider situations in which our capacity for empathy tends to falter, such as when confronted with individuals grappling with "clinical depression, persistent and unrelenting grief, or the incapacitating, enduring agony of injury and

illness" (Sabo). The reluctance to empathize in such cases often stems from the apprehension that it could potentially subject us to their suffering. A pertinent example lies in the domain of medical professionals and nurses who frequently engage with patients in the advanced stages of their conditions, often leading to burnout and compassion fatigue due to their heightened empathetic involvement. Compassion Fatigue is a natural consequent behavior and emotions resulting from knowing about a traumatizing event experienced by a significant other" (Sabo, 2016). It is essentially stress that results from helping someone who is traumatized. Burnout can result from emotional exhaustion and is very common in nurses and medical professionals. Because

Nurses are often overwhelmed by being close to a patient, they often lose themselves and end up being "swallowed" by other people's (specifically their patient's) feelings. (Maatta). Palliative and Hematology/Blood and Marrow Transplant Care Nurse Holly worked with a patient and stated that she had allowed herself "to imagine that WG (her patient) as my mother. The thought of her suffering silently as this woman does, was becoming too much for me" (Sabo). To further explain Spaulding's argument, empathy is a strong emotion, so there are many consequences when empathizing with others in critical conditions.

Spaulding continues to argue that empathy is motivated by mentioning that sometimes "empathizing with others would cost us money, time, or other resources" (Spaulding, 6). She contends that when donating money or resources, we end our empathetic suffering because we feel satisfied with what we have done and end up feeling fulfilled. She states that empathizing and donating to each cause would inevitably end up giving up too much, which would be uncomfortable. To bridge this aspect of her argument and emphasize the motivated nature of empathy, by allocating resources to charitable endeavors, we effectively "avoid empathizing by avoiding exposure to the suffering, modifying our attention when exposure is unavoidable, or shifting our focus to appraisal" (Spaulding, 6).

In order to be motivated to feel empathy, Spaulding argues that the person who has the option to feel empathy must first have the desire to be empathetic. Above, I mentioned how Spaulding argues that many people choose to be empathetic when it results in positive outcomes for themselves. She also argues that the empathy user will choose to use it when it benefits them. For example, they might feel more inclined to empathize when it can help strengthen a relationship with a friend, family member, or romantic partner (Zaki, 1629). We might tend to "be angry on behalf of a friend who has been wronged, or indigent on behalf of a kin who have been insulted, or anxious on behalf of our partner interviewing for a new job" (Spaulding, 7). By accruing social advantages from exhibiting empathy, we can foster an inclination to cultivate empathetic sentiments towards others. Strengthening group ties drives us to empathize because we desire to be socially desirable.

Analysis of Spaulding's Argument

In this section of my paper, I will analyze Spaulding's argument. I will share my opinions and counter what she says because the claim that empathy should not be relied on for

making moral decisions is false.

In order for empathy to be motivated, empathy must be driven or influenced by certain factors or reasons. Some people might believe empathy is motivated because we might gain internal or external benefits after feeling empathetic. We often try to empathize with situations that we know will result in happy endings. Is this really true? I will argue against this claim in order to prove that empathy is necessary for making moral decisions.

Although we can feel empathetic toward situations with happy endings, we also tend to do the opposite; we might even be more likely to feel empathetic toward situations that do not necessarily have happy endings. When walking on the street and noticing a person who is homeless, our first thoughts might be to feel bad or to feel the urge to help because we imagine what it would be like to be in their position. Often, people with OCD focus on the fear of becoming homeless and think about "going through financial difficulty, changing jobs or losing employment, medical emergencies…" (Quick). We have no idea what happens next for a person who is homeless, and it may not always be a positive result. We do not avoid feeling empathy towards situations that we know might not always be positive and uplifting because unhappy situations are always around, whether we want them to be.

My Argument

In this section, I will counter Spaulding's assertion, wherein she posits that empathy might adversely affect ethical decision-making. On the other hand, I contend that empathy is indispensable for informed moral judgments.

First, I will argue that we will miss out on morally relevant information without empathy. Without empathy, we are unable to have access to the ability to put ourselves in the shoes of others. Without empathy, we are denied the capacity to immerse ourselves in the experiences of others and grasp diverse viewpoints. Unlike other emotions—such as compassion, guilt, anger, and sympathy—that may not inherently facilitate such broadened perspectives, empathy uniquely enables us to inhabit and sense another person's vantage point. They do not allow you to be and feel another person's perspective. Without empathy, we will lack total emotional capacity and understanding of situations, which essentially decreases our EI (empathy intelligence).

Our emotional intelligence has been proven to be positively correlated with ethical decision-making. For example, whoever is making the decisions can understand the emotions of themselves and others; they can ultimately intercept potential unfortunate outcomes because they can address emotional issues before the decision is made (Hess & Bacigalupo; Huy). People with substantial emotional intelligence can be more skillful at interpreting ethics in others' actions. This can ultimately lead to positive involvement with ethical decisions. (Harati; Mesmer-Magnus). A 2012 study that showcased the idea of individuals with high EQs and ethical decisions showed that "individuals with high emotional intelligence made more sound ethical decisions – even in highly dynamic scenarios (Krishnakumar & Rymph)" (Keiper, 6) Through this case the correlation between emotion intelligence and ethical decisions are directly

associated with one another.

Since empathy is a result and is needed to have an increased EI (Hajibabaee F et al.) The relationship between empathy and emotional intelligence among Iranian nursing students. (Int J Med Educ. 2018 Sep 19;9:239-243. doi: 10.5116/ijme.5b83.e2a5. PMID: 30244237; PMCID: PMC6387768.) These studies that show the connection between emotional intelligence and empathy relate to my earlier conclusion that we cannot access morally relevant information without empathy. Because empathy increases our EI, we are able to see essential situations from different standpoints. This allows us to increase our perspective and lets us see things differently. This can help us come to conclusions when making important decisions. For example, a study accumulated in 2005 showed that the 12 high-care companies tested were more "innovative and better at knowledge transfer and creation"(Zárraga & Bonache). This experiment showed that entrepreneurs who tend to be more considerate of their employee's attitudes and feelings ultimately have an advantage in leading teams (Humphrey).

Empathy is not itself motivated; it just happens and is trained. Therefore, we should practice empathy as a moral virtue to counteract motivation problems. For someone to feel empathy, they do not have to want to be empathetic towards another person. Many of our subconscious behaviors originate from our childhood experiences, shaped by the lessons instilled in us during that time. Parents' differentiating parenting styles harm their children, whether they know it or not. Factors such as their manner of interaction and the extent of attention they provide yield divergent trajectories for their children's futures. Many studies "...have reported that a child's ability to form and maintain healthy relationships throughout life may be significantly impaired by having an insecure attachment to a primary caregiver (Winston & Chicot). While numerous external factors influence the emergence of this emotion at an early age, culminating in habitual responses, this does not inherently imply that the emotion is driven by motivation. Instead of saying that empathy is motivated, I would argue that empathy is triggered, which makes empathy just as reliable as other moral tools. Every emotion and "moral" tool has its own trigger. For example, most humans might feel guilty after lying about eating the last piece of chocolate, the trigger being lying, and the outcome of this trigger would be to feel guilty. Spaulding mentioned that other human emotions, such as guilt, are more potent tools for making moral decisions (Spaulding). I would argue that emotions like guilt also have triggers, just like empathy, which allows us to feel them in the first place. Empathy can be triggered by many other emotions, such as watching someone get hurt, seeing individuals live in poverty, listening to traumatic events, and celebrating someone else's achievement. (Stadler) Like every other emotion, how we are raised affects when and how we feel them. It is not the fact that empathy is motivated by our desires and what outcomes are best for us, but it is just simple brain chemistry.

Considering Counter Arguments

A counterargument that might be made against relying on empathy for ethical decision-making because it stems from our origins in childhood development, making it

unmotivated, is that it is unreliable. The argument posits that since empathy is rooted in earlier experiences and is often molded by our upbringing, it lacks a solid and objective basis. As a result, its unreliability is brought to the forefront, suggesting that relying on empathy alone might lead to biased or inaccurate judgements.

Suppose childhood experiences shape our empathy by exposing us to varying degrees of nurturing, cultural norms, and personal biases. These factors can lead to an uneven development in empathetic responses, potentially favoring certain emotions, situations, or perspectives of others. Consequently, empathy could inadvertently reinforce our existing biases, limiting our ability to understand and engage with viewpoints that differ from our own.

However, empathy is also a skill that can be cultivated and strengthened over time. The journey towards learning to control empathy encompasses considering human life and experiences, engagement with narratives and art, and the profound impact of stories (Spiro).

The foundation of empathy rests upon recognizing the intrinsic value of every human life and the kaleidoscope of experiences they encounter. In order to cultivate empathy, one must acknowledge each individual's unique perspectives, challenges, and emotions. This entails introspection and a genuine effort to under the multifactored nature of existence. One potent method to nurture empathy is listening and reading stories and novels. These literary devices serve as gateways into the thoughts and emotions of both nonfictional and fictional characters. This allows a chance to step into their shoes and encounter their life from their viewpoint. Immersing oneself in narratives encourages the exploration of characters' feelings and motivations, thereby fostering a deepened understanding of their experiences. The diversity of characters and situations encountered in literature helps broaden one's horizons regarding empathy. The discussions surrounding narratives, paintings, and role models also play a similar role in empathy development. Analyzing characters' choices, decoding symbolism within art, and debating motivations during dialogues all contribute to increasing empathetic capabilities. These methods foster a habit of seeing scenarios from various angles, nurturing the ability to grasp the sentiments and predicaments of others.

Music, a universal language, fosters empathy and broadens perspectives. Artists like SZA and Drake, prominent figures in the R&B genre, exemplify how music can bridge the gap between individuals and increase understanding. Through their songs like "Mr. Right Now," "Blind," "Search and Rescue," "Seek and Destroy," and "Telekinesis," they skillfully communicate their contrasting viewpoints and intricate emotions, allowing listeners to step into different perspectives. Another example of this is Taylor Swift and Kanye West. At the 2009 MTV Video Music Awards, Swift won the award for Best Female Video for her hit song, "You Belong with Me." Once she was given the award, West stormed on stage during Swift's acceptance speech and grabbed the microphone, declaring that Beyonce's "Single Ladies (Put a Ring on It)" deserved the award instead. This interruption caused much backlash, leaving Swift shocked and audiences divided. In 2016, Kanye West released the song "Famous" containing the lyrics "I feel like me and Taylor might still have sex, / Why? I made that b**** famous." This ultimately caused a lot more controversy over the years, and later, in 2017, Taylor Swift released

an album called "Reputation." She released multiple songs called "This Is Why We Can't Have Nice Things" and "Look What You Made Me Do, " referring to her controversy with Kanye West. Both artists, who contain large platforms and fan bases, could share their sides of their stories through their songs and lyrics.

Conclusion

In conclusion, the question of whether empathy should be utilized for ethical decision-making is a multifaceted and nuanced one. Throughout this essay, we have explored the intricate relationship between empathy and motivation, analyzing the arguments put forth by both proponents and critics of using empathy as a moral compass. While Shannon Spaulding's argument raises valid concerns about the potential pitfalls of relying solely on empathy, my evaluation suggests that empathy remains reliable for ethical decision-making when wielded as a skill and virtue.

Spaulding's assertion that empathy can be motivated by self-interest and selective biases is an important consideration. However, a closer examination reveals that empathy, much like other emotional responses, is triggered rather than consciously controlled. We cannot choose whether to feel empathy in any given situation, and it arises naturally in response to various stimuli, often outside our direct control. Empathy's ability to facilitate understanding, perspective-taking, and compassion should not be dismissed solely based on its unconscious nature.

All the potential consequences of relying solely on empathy when making ethical decisions raise essential considerations, but it does not negate the inherent value of empathy itself. Empathy, when consciously cultivated, can offer a powerful lens through which to understand the experiences of others, fostering compassion and contributing to more thoughtful and ethically sound judgments. Rather than discarding empathy due to its potential limitations, we should embrace it as a virtue to be practiced, allowing it to enhance our moral reasoning and guide us toward a more moral society.

Works Cited

1. Spaulding, Shannon. *Motivating empathy* pp. 1–17. Mind & Language
    https://doi.org/10.1111/mila.12469

2. Batson, C. Daniel, and Laura L. Shaw. "Evidence for altruism: Toward a pluralism of
    Prosocial motives." *Psychological Inquiry*, vol. 2, no. 2, Apr. 1991, pp. 107–122,
    https://doi.org/10.1207/s15327965pli0202_1.

3. Kleinlogel, Emmanuelle P., and Joerg Dietz. "Ethical decision making in organizations: The
    role of empathy." Organizing through empathy. Routledge, 2013. 115-129.

4. Spiro, Howard. "What is empathy and can it be taught?." Annals of internal medicine 116.10
    (1992): 843-846.

5. Nortje, Alicia. "Empathy 101: 3+ Examples and Psychology Definitions."
    PositivePsychology.com, 15 Mar. 2024, positivepsychology.com/empathy-psychology.

6. Zaki, Jamil. "Empathy: a motivated account." Psychological bulletin 140.6 (2014): 1608.

7. Sabo, Brenda M. "Adverse psychosocial consequences: Compassion fatigue, burnout and
    vicarious traumatization: Are nurses who provide palliative and hematological cancer
    care vulnerable?." Indian Journal of Palliative Care 14.1 (2008).

8. Määttä, Sylvia M. "Closeness and distance in the nurse‑patient relation. The relevance of
    Edith Stein's concept of empathy." Nursing Philosophy 7.1 (2006): 3-10.

9. Lpc, Stacy Quick. "Fears About Becoming Homeless." *NOCD*, 30 Jan. 2023,
    www.treatmyocd.com/what-is-ocd/common-fears/fear-of-being-homeless-ocd.

10. Hess, James D., and Arnold C. Bacigalupo. "Enhancing decisions and decision‑making
    processes through the application of emotional intelligence skills." Management decision
    49.5 (2011): 710-721.

11. Huy, Quy Nguyen. "Emotional capability, emotional intelligence, and radical change."
    Academy of Management review 24.2 (1999): 325-345.

12. Harati, Lina Wagih. Relationship between emotional intelligence and ethical decision
    making in educational leaders. Diss. Saint Louis University, 2013.

13. Hajibabaee, Fatemeh, et al. "The relationship between empathy and emotional intelligence
    among Iranian nursing students." International journal of medical education 9 (2018):
    239.

14. Krishnakumar, Sukumarakurup, and Doug Rymph. "Uncomfortable ethical decisions: The
    role of negative emotions and emotional intelligence in ethical decision-making."
    Journal of Managerial Issues (2012): 321-344.

15. Keiper, Margaret C., and Eduardo Wilner. "Emotional intelligence & ethical decision
    making in hunting tourism: a virtue based approach." Tourism Recreation Research
    (2023): 1-12.

16. Zárraga, Celia, and Jaime Bonache. "The impact of team atmosphere on knowledge
    outcomes in self-managed teams." Organization studies 26.5 (2005): 661-681.

17. Humphrey, Ronald H. "The benefits of emotional intelligence and empathy to
    entrepreneurship." Entrepreneurship Research Journal 3.3 (2013): 287-294.

18. Maibom, Heidi L.. Empathy, 2019, doi:10.4324/9780415249126-L154-1. Routledge
        Encyclopedia of Philosophy, Taylor and Francis,
        https://www.rep.routledge.com/articles/thematic/empathy/v-1.
19. Gavilanes, Grace, and Sophie Dodd. "A Complete Timeline of Taylor Swift and Kanye
        West's Feud." Peoplemag, 8 Dec. 2023,
        people.com/music/kanye-west-famous-inside-his-and-taylor-swifts-relationship-history.
20. Winston, Robert, and Rebecca Chicot. "The importance of early bonding on the long-term
        mental health and resilience of children." London journal of primary care 8.1 (2016):
        12-14.
21. Stadler, Jane. "The empath and the psychopath: Ethics, imagination, and intercorporeality in
        Bryan Fuller's Hannibal." Film-Philosophy 21.3 (2017): 410-427.

Evolving Diets and Health: The Influence of Food Science and Nutrition and Their Effects on the Health of the Population in the United States By Yewon Kim

Abstract

This review paper aims to evaluate the food science and nutrition landscape in the United States over the last 50 years and how it affects people's health. In today's day and age, there are many different types of diets and dietary advice that spark controversy and confusion among the general public. With rising rates of chronic diseases such as obesity and diabetes, it's imperative that the correct dietary advice is accessible to the general public. This paper analyzes food processing and the nutritional data that influences dietary guidelines. It also addresses the lack of nutrition education within schools in the US and other challenges in the promotion of healthy eating habits. By evaluating these processes, this paper sheds light on nutritional guidelines to better equip people to make appropriate food choices for their health.

Keywords: Nutrition, Food Science, Diet, United States, Public Health

Introduction

Navigating the complex landscape of nutrition can be challenging. Nutrition and food science are complex but closely related fields of study that explore the science behind food and its impact on our health. Nutritional science focuses on how the body processes nutrients from the foods we eat and how they affect our well-being. Food science, on the other hand, looks at food's physical, chemical, and biological aspects, including the manufacturing, processing, and production of food (University of Auckland, n.d.).

There is substantial information available in the public domain, leading to confusion and disagreements among the general public. Conflicting nutritional information makes it difficult for people to separate fact from fiction when they make diet and lifestyle choices. Because of the growing field, there is even disagreement among professionals, and there is a lack of adequate training specifically among physicians which may also lead to uncertainty (Lustig, 2021).

In the world of nutrition and food science, popular fad diets and myths about certain foods can be seen everywhere, promoted by food companies, dietitians, and even doctors. People place trust in them, not fully understanding the science behind or the source of the diets, including the role of the government and food industry in shaping them. In addition, common beliefs about weight gain and weight loss, and the demonization of certain types of foods often result in misguided dietary choices. For example, the hype surrounding diets such as veganism and the ketogenic diet may promote unhealthy lifestyles for certain individuals. This negatively impacts the dietary choices people make when it comes to their health and well-being, especially for people who may be more impressionable.

Ironically, despite the United States being one of the wealthiest nations in the world, a large portion of the population suffers from malnutrition (World Health Organization, 2023). Malnutrition refers to the deficiencies or excesses in nutrient intake and the imbalance of

essential nutrients that can occur in people of all sizes (World Health Organization, 2023). Furthermore, the rate of chronic diseases such as obesity and heart disease continues to rise everywhere, which is especially true in the US. According to the Centers for Disease Control and Prevention (CDC), 6 out of every 10 adults in the US have at least one chronic disease, and about 4 in 10 have two or more chronic diseases (Centers for Disease Control and Prevention, 2022).

Therefore, it is necessary to understand the influence of nutrition and food science in our lives to make healthier and sustainable food choices. With reliable information, individuals can make informed and health-conscious food choices, live healthier lifestyles, and possibly prevent chronic disease. To begin, let's take a look at the fundamentals of calories and nutrients to gain a better understanding of what defines a healthy diet.

Section 1. The Fundamentals of Nutrition
Calories

Calories are units of energy that measure the energy content of the food we eat. Caloric intake is an important factor when considering what or what not to eat for most people. However, this can be a controversial topic in the field of nutrition, often being the target when it comes to weight gain. The idea of "calories in and calories out" is a misunderstood concept that is more complex than it may seem. People experience different outcomes from eating the same number of calories depending on their gut microbiome, the body's metabolism, and the type of food they eat (Harvard Health Publishing, 2020).

It is also crucial to understand that not all calories are created equally. Different types of food with varying nutritional content have different effects on our bodies and health even when they contain the same amount of calories. For example, half an avocado contains roughly the same amount of calories as a small bag of Cheetos. But the avocado is rich in healthy fats, fiber, and protein, while the Cheetos lack healthy nutrients and contain artificial flavorings and preservatives that are harmful to the body.

Although calories do play a role in our health, we should not just focus on them to determine what is good or bad for us. The source of those calories, the nutritional content of the food, and how the food has been processed have a bigger impact on maintaining a healthy weight and on our overall well-being (Osilla & Sandeep Sharma, 2019).

Carbohydrates

Carbohydrates are the primary source of energy for humans. They provide our body with glucose, which is then converted into energy used for bodily functions and physical activity. Each gram of carbohydrate (excluding fiber) has 4 calories. Despite their importance, carbohydrates have a bad reputation among the public with the rising popularity of low-carb diets like the ketogenic diet (Mayo Clinic, 2022a). Nevertheless, it is important to incorporate healthy sources of carbohydrates in our diet because they are vital to our health. They provide important nutrients, protect against disease, and help with weight management (Mayo Clinic, 2022a).

Carbohydrates come in various forms such as sugars, fibers, and starches. Sugar is the simplest form of carbohydrate, while starch is a complex carbohydrate made of many sugar units bonded together. Fiber is another essential form of carbohydrate that provides many health benefits. Furthermore, the quality of carbohydrates significantly impacts health outcomes. Unprocessed whole carbohydrates that are found in whole grains and vegetables promote good health by delivering essential vitamins, minerals, and fiber (Harvard T. H. Chan School of Public Health, 2017b). In contrast, highly processed refined carbohydrates are easily digested, contributing to weight gain and increasing the risk of diseases such as diabetes and heart disease (Harvard T. H. Chan School of Public Health, 2017b). Making healthier choices when it comes to the sources and types of carbohydrates in our diet is crucial.

Dietary Fiber

Fiber is a type of carbohydrate that is found in whole plant foods. Since fiber cannot be broken down into sugar molecules by our body, it passes through our digestive tract without providing any calories. It regulates the body's use of sugars and helps control hunger and blood sugar levels (Harvard T. H. Chan School of Public Health, 2017b). There are two main types of fiber: soluble and insoluble. Soluble fiber can be dissolved in water and helps lower glucose levels and lowers blood cholesterol (Mayo Clinic, 2022b). On the other hand, insoluble fiber does not dissolve in water; it can help food move through the digestive system and prevent constipation (Mayo Clinic, 2022b).

Fiber is often referred to as a prebiotic, which is a food source for the gut and plays a crucial role in the development and maintenance of the gut microbiome (Carlson et al., 2018). It is essential to incorporate a wide variety of high-fiber foods containing both kinds of fiber into a healthy diet. However, adding too much fiber to the diet too quickly can promote abdominal bloating and cramping. Increasing fiber gradually in one's diet will help improve the gut microbiome while avoiding negative side effects (Mayo Clinic, 2022b).

Dietary Fat

Dietary fat is one of the most misunderstood macronutrients due to the misconceptions about weight gain and other health issues that are associated with it. Each gram of fat has 9 calories. This is more than twice the amount of calories compared to carbohydrates and proteins (Cleveland Clinic, 2019). The high calories contained in fats create a bad reputation among people who are trying to lose weight. However, not all dietary fats are considered unhealthy. They are essential for our bodies as they are broken down into fatty acids that are used by the body to absorb vitamins (MedlinePlus, 2015). Fats also serve as the building blocks for hormones and cell membranes.

There are different types of fats including unsaturated fats, saturated fats, and trans fats. Unsaturated fats that come from sources such as vegetables, nuts, and fish oil remain liquid at room temperature. Saturated fats usually come from meat and dairy products and remain solid at room temperature. Saturated fats tend to raise cholesterol levels in the blood and are commonly

associated with a higher risk of cardiovascular disease (Mayo Clinic, 2023). Cutting back on saturated fat can be beneficial to health if it is replaced with good fats such as polyunsaturated fats (PUFAs) (Harvard T. H. Chan School of Public Health, 2018). Omega-3 fatty acids are a type of PUFA that have health benefits including lowering levels of triglycerides and the risk of heart and blood vessel diseases (Mayo Clinic, 2023). Sources of omega-3 fatty acids include oily fish, seeds, and nuts. Triglycerides are fat cells that circulate in the bloodstream and are stored in fat cells in the body (Harvard T. H. Chan School of Public Health, 2020a). High levels of triglycerides increase the risk of diseases of the heart and blood vessels. Trans fats are a type of fat that raises small high-density (LDL-B) cholesterol and lowers good (HDL) cholesterol levels, causing harmful health effects even in small amounts (Harvard T. H. Chan School of Public Health, 2018).

Focusing on eating good fats and limiting unhealthy fats in our diets is another important component of eating a healthy, balanced diet. This emphasizes eating unsaturated fats that come from vegetables, nuts, and fish while avoiding saturated and trans fats (Mayo Clinic, 2023).

Protein

Protein is an essential macronutrient that the body needs to make muscle, bone, and other compounds such as enzymes and hormones. Like carbohydrates, each gram of protein contains 4 calories. Proteins are made from 20 different types of building blocks called amino acids. The human body can only make 11 out of 20 essential amino acids, so it is essential for us to consume the 9 other amino acids for our bodies to use (Harvard T. H. Chan School of Public Health, 2022).

However, there are many people worldwide who don't get enough protein, especially young children and the elderly, resulting in growth failure and loss of muscle mass. In contrast, very high protein intakes can be harmful to the kidneys and liver and can also lead to the loss of calcium (Better Health Channel, 2022). Different foods contain different amounts of essential amino acids. For vegetarians or vegans, consuming a wide variety of protein sources is crucial since not all plant-based proteins contain all the essential amino acids that are needed for our bodies (Better Health Channel, 2022). Meanwhile, meat and dairy provide all the essential amino acids that the body needs but have to be balanced with the risk of consuming unhealthy fats. Protein is essential to everyone's health and well-being. Eating a variety of protein-rich foods as a part of a balanced diet is critical.

Section 2. Food Labeling and Marketing
Food Labels

When buying a food product, one often finds a nutrition facts label on the back (Figure 1) (FDA, 2023b). These food labels play a crucial role in helping consumers make healthier food choices. In the United States, the food label was first mandated by the FDA under the Nutrition Labeling and Education Act of 1990 to help consumers make informed food choices (Harvard T. H. Chan School of Public Health, 2021). It provides specific information about the nutritional

content, serving size, and amount of calories of a food product (Figure 1). However, these labels can often be misleading and difficult to understand for the average consumer, leading to misunderstandings and misinterpretations of the content of the food (National Institute on Aging, 2022).

Serving Size

One of the many misinterpretations made by consumers is the serving size that can be seen on the top of the nutrition facts label (see #1 in Figure 1). It is essential to know that this is not a recommendation about how much to eat but is a reference point that reflects the average amount that people usually eat or drink, which could reflect overeating or overdrinking (FDA, 2023a). However, there may be confusion about the difference between serving size and portion size. Many foods that come as a single portion contain multiple servings, but serving size is the amount listed on the nutrition facts label, while portion size is how much a person chooses to eat at one time (American Heart Association, 2015). Serving sizes are set by the FDA based on the average amount of food or beverage people consume (Harvard T. H. Chan School of Public Health, 2021). It is standardized using familiar units such as cups or pieces and includes a metric measurement such as grams (g) (see #1 in Figure 1). This helps consumers compare the nutritional content of the food with other food products based on their nutritional needs.

Percent Daily Value (%DV)

The Percent Daily Value (%DV) tells how much a nutrient in a single serving of food or drink contributes to a total daily 2000-calorie diet (See #4 in Figure 1) (Centers for Disease Control and Prevention, 2019). The percentage serves as a reference point for consumers to determine if a serving of food is high or low in a particular nutrient. Generally, a 5% DV or less is considered to be low and a 20% DV per serving of food is considered to be high (FDA, 2021). However, everyone's daily caloric intake varies depending on factors such as age and activity level, so a 2000-calorie reference guideline may not be suitable for everyone. For example, an average 18-year-old female with low activity levels would only require 1600 calories a day to maintain a healthy weight. It is recommended for individuals to consider their dietary needs to make appropriate choices in their diet.
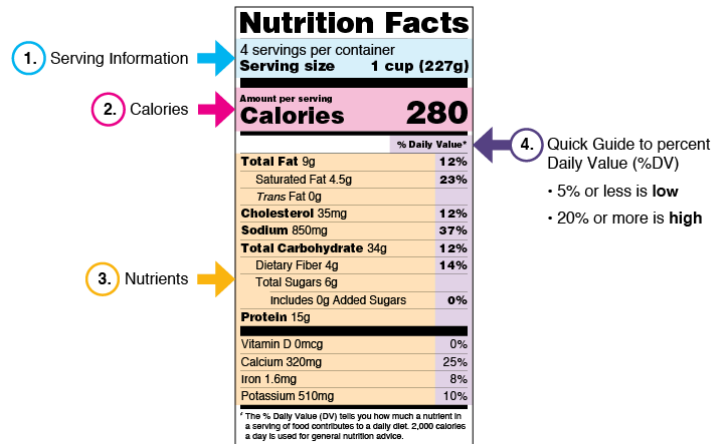
Figure 1. Sample Nutrition Facts Label for Frozen Lasagna

Food Promotion and Marketing

Over the years, the way people perceive and access food has changed dramatically, largely due to the food industry's development of new strategies aimed at influencing consumer behavior (Martinho, 2020). The central focus of big food corporations has become the promotion and marketing of food products instead of providing healthy and nutritious food that consumers need. Corporations spend billions of dollars each year to influence the behavior of consumers through a variety of tactics (Harvard T. H. Chan School of Public Health, 2012b).

Today, the food choices made by consumers are influenced by a variety of factors, including price, food labels and packaging, convenience, and various marketing strategies used by food companies (for example, the placement of packaged food in grocery stores). This web of influences shapes dietary decisions, impacting health and well-being even beyond people's consciousness (Martinho, 2020).

One significant cultural shift is the transition from traditional home cooking to prioritizing convenience. This driving factor has accelerated the growth of the food industry and increased the availability of processed foods. Societal changes have led to the food industry's development of new products that can be consumed quickly with minimal preparation. The demands of modern lifestyles have reshaped people's preferences and their eating habits, favoring quick and easy meals over home-cooked meals (Martinho, 2020).

Advertisements to create brand awareness and promote food products can be seen everywhere: grocery stores, social media, billboards, commercials, etc. The media constantly communicates with consumers, conveying messages that increase food sales with the repetition and visibility of advertising messages. This is frequently used to influence children, shaping their preferences from an early age. Food packaging also attracts many consumers with pretty designs, vibrant colors, and clear labels (Martinho, 2020). As consumers become more health-conscious, labels often include buzz words such as "low fat," "organic," and "natural," even though these claims may not be directly related to a person's health.

As a result of technological developments in food science, food companies add monetary value to food through processing, while the value of raw foods is actually a fraction of what consumers pay in the supermarket (Martinho, 2020). This aligns with the food industry's goal of selling more products. Food companies persistently encourage people to buy more and eat more to create more profit, and one of the ways they do this is by increasing the size of food portions. Offering larger portion sizes encourages consumers to buy more than they intended. This is often seen in fast-food restaurants with "supersize" options. Furthermore, the food industry strategizes the location of certain food items to increase sales. For example, supermarket checkout areas often feature tempting food items that can be easily picked up. Products that are displayed at eye level are more likely to be noticed and purchased (Martinho, 2020). Understanding these influences can empower people to make more informed decisions based on their preferences and needs (Harvard T. H. Chan School of Public Health, 2012b). Consumer awareness is a crucial tool for navigating the complex landscape of making food choices.

Section 3. The Influence of Processed Foods and Dietary Guidelines on Public Health
Processed Foods

Processed food can be seen everywhere, but there is even more to it than the packaged junk foods one might encounter in the grocery store. The definition of processed food varies depending on the source, but most foods sold in the supermarket are processed to some degree. Being "processed" means that the food has been changed from its original form (Harvard T. H. Chan School Of Public Health, 2019). The main reasons to process food are to eliminate microorganisms, extend shelf life, and make the food more appealing to consumers (Cleveland Clinic, 2023). Some of these processes include milling, blanching, canning, freezing, pasteurization, high-pressure processing, and dehydrating (Better Health Channel, 2012). During this process, the nutritional value of a food is almost always altered by the type of processing it undergoes. Food processing that exposes foods to high heat, light, or oxygen causes the greatest nutrient loss (Better Health Channel, 2012). It is vital to distinguish between different degrees of processing and their impact on health.

First, there are unprocessed or minimally processed foods, which include the natural edible parts of plants and animals. They are only slightly altered and do not significantly change the nutritional content of the food. The food is usually cleaned, refrigerated, pasteurized, fermented, or frozen. These include fresh fruits and vegetables, whole grains, nuts, and meats without any added sugar or artificial sweeteners (Table 1) (Harvard T. H. Chan School Of Public Health, 2019).

The next degree of processed foods are food items that are enhanced in flavor and texture or are increased in durability, becoming different from their original state. Almost all food products are processed in some way or form before they reach the consumer (Harvard T. H. Chan School Of Public Health, 2019). They are made from at least 2-3 ingredients and can be eaten without preparation. Some examples are canned fruits and vegetables, cheese, bread, and canned fish (Table 1).

Ultra-processed foods, also referred to as "highly processed foods," are foods that have been altered to include salt, sugar, fat, artificial colors, flavors, and preservatives that are extracted from other sources (Cleveland Clinic, 2023). They are mass-produced with low-cost ingredients, which makes them cheap and highly profitable. The high amounts of additives and preservatives increase shelf life and palatability, but these foods tend to be low in fiber and nutrients. Some examples include Oreos, Cheetos, soda, and ice cream (Table 1). Ultra-processed foods continue to replace unprocessed and minimally processed foods in people's diets. According to a study from the U.S National Health and Nutrition Examination Survey, 60% of total calories in the U.S. diet consist of ultra-processed foods (Harvard T. H. Chan School Of Public Health, 2019). There are also associations between the increasing sales of ultra-processed foods and the rise in obesity.

Nevertheless, just because a food is processed doesn't mean that it lacks nutritional value. From a nutritional standpoint, certain processed foods can still offer valuable dietary benefits (Cleveland Clinic, 2023). However, in general, prioritizing a diet that is rich in highly nutritious unprocessed foods is recommended for optimal well-being.

Table 1. Example of the spectrum of food processing from a variety of food products

Unprocessed foods	Minimally processed foods	Processed foods	Ultra-processed foods	Ultra-processed foods of low nutritional value
Whole apple	Prepackaged apple slices with no additives	Unsweetened applesauce made with apples, water, and ascorbic acid to prevent browning	Sweetened applesauce that contains the prior ingredients plus high fructose corn syrup	Apple juice drink with high fructose corn syrup and added coloring
Whole oat groats	Steel-cut oats, rolled oats	Instant oats with added sugar and a preservative only to enhance freshness	Instant flavored oatmeal with added sugar, artificial flavorings, and other additives to improve texture and freshness	Low-fiber packaged oat-containing cookie (mostly made of refined flour and sugar)

Dried chickpeas	Chickpea flour made from dried finely ground chickpeas; chickpea pasta	Canned chickpeas; store-bought hummus made with chickpeas, spices, and oil without preservatives	Store-bought hummus made with chickpeas, salt, spices, and artificial flavors	"Chickpea" chips that are made with mostly rice or potato flour and are high in added salt and oils
Peanuts in the shell	Shelled plain peanuts	Natural peanut butter made with only peanuts and salt	Peanut butter with added sugar, salt, and emulsifiers	Peanut butter candy
Homemade veggie burger made with brown rice, lentils, sweet potato, and cooked kale			Packaged frozen veggie burgers or plant-based meat substitutes with added salt and seasonings; a good source of protein and fiber	
	Homemade or store-bought plain yogurt with only pasteurized milk	Store-bought plain yogurt made with pasteurized milk, live active cultures, and food starch (thickener)	Yogurt with a small amount of added sugar, and pectins and gums to thicken/emulsify; a good source of protein and calcium	Yogurts higher in added sugars or fruit concentrates, artificial flavors, and gums to thicken/emulsify; not a significant source or protein or calcium
Fresh fish	Unseasoned frozen fish filets	Canned or frozen or fresh fish with seasoning	Breaded fish sticks	

The Dietary Guidelines for Americans

      For over a century, dietary guidelines have been provided by the federal government in

the United States. The Dietary Guidelines for Americans (DGAs) were originally designed to guide federal nutrition policies (LDN, 2021). Today, their influence extends to food policies, food assistance programs, and consumer education programs at the federal, regional, state, and local levels (Jahns et al., 2018).

In the first half of the 20th century, the DGAs focused primarily on the significance of food groups in a healthy diet and the roles of minerals and vitamins in preventing disease. Later, the first publication of the DGAs was released in 1980 (Jahns et al., 2018). Since then, Dietary Guidelines have focused on what components make up a healthy diet and the relationship between individual nutrients, foods, food groups, and health outcomes. Now, scientific research investigates the relationship between overall dietary patterns and various health outcomes. The DGAs are updated every five years, each building on the previous set of guidelines. These guidelines provide a framework for policymakers and nutrition and health professionals to help individuals consume a nutritionally adequate diet (LDN, 2021).

Dietary guidance has constantly evolved to focus on a holistic perspective on nutrition, not just on individual nutrients. The interaction between nutrients, dietary habits, and lifestyle choices is complex and multifaceted. Modern dietary guidelines emphasize the importance of understanding and making informed food choices and promoting a healthier, more sustainable future for humanity and the planet.

Changes in Diet and the Rising Rates of Chronic Disease in the United States

The dietary patterns among Americans and their effects on the health of the population have shifted dramatically over the years. In the past, a poor diet was associated with undernutrition in the US, but today, it is often associated with excess calories, saturated fats, trans fats, added sugars, and sodium (Walker, 2015). Chronic diseases such as obesity, cardiovascular disease, type 2 diabetes, and certain types of cancers affect the greatest number of Americans among various health risks and are also closely related to diet (Symbols et al., 2010). Americans today consume too many calories, saturated fats, trans fats, added sugar, and sodium, and consume too little vitamin D, calcium, potassium, and fiber.

However, the greatest nutritional challenge in the US is chronic disease caused by excess intakes of certain nutrients rather than nutritional deficiencies. The overall consumption of ultra-processed foods has increased in the US, making it one of the key drivers in the obesity epidemic (NYU School of Global Public Health, 2021). Almost 35% of adults in the US are obese, and it is estimated that it will increase to almost 50% within 15 years (Symbols et al., 2010).

Moreover, the COVID-19 pandemic led to an increase in eating less nutritious, shelf-stable foods (Monroe-Lord et al., 2023). The results from a study revealed that the consumption of grains, fruit, lean proteins, and dairy decreased, while the consumption of unhealthy foods containing fat, sugar, and other sweet items increased due to the COVID-19 pandemic (Monroe-Lord et al., 2023). The quality of diets has reduced since the pandemic

among Americans, raising more concerns about long-term health consequences for the US population.

The Role of Nutrition in Treating Chronic Diseases

Chronic diseases are long-lasting conditions that require ongoing medical care, often lasting for one or more years (Gropper, 2023). Some common examples include cardiovascular disease, cancer, diabetes, and Alzheimer's disease. According to the Centers for Disease Control and Prevention (CDC), they are the leading causes of death and disability, and 70% of annual deaths are due to chronic diseases. These conditions not only lower the quality of life but contribute to rising healthcare costs— 75% of US healthcare dollars are used to treat and manage these diseases (Harvard T. H. Chan School of Public Health, 2017a).

Many of these chronic diseases are preventable because they are linked to lifestyle choices, particularly diet and physical activity (Gropper, 2023). The phrase "you are what you eat" illustrates the connection between our food choices and our overall health. Diet is a crucial lifestyle factor that influences the development of many diseases (Stiepan, 2023). A poor diet is not only associated with weight gain and obesity, but its effects contribute to the development of many chronic conditions. A healthy diet helps children grow and develop properly, while adults who eat a healthy diet live longer and have a lower risk of obesity, heart disease, type 2 diabetes, and certain types of cancers (Gropper, 2023).

Diabetes is a chronic disease related to the body's ability to produce and use insulin, a hormone that regulates blood glucose (Cleveland Clinic, 2022). Being overweight or obese makes it more likely for someone to develop diabetes than someone with a healthy weight. About 9 in 10 cases of diabetes in the US can be avoided by making lifestyle changes, especially in diet and nutrition (Harvard T. H. Chan School of Public Health, 2016). A healthy diet helps with maintaining a healthy weight, reducing the risk of diabetes.

High blood pressure and high cholesterol are related to heart disease and stroke (Harvard T. H. Chan School of Public Health, 2022b). Decreasing sodium and sugar intake, eating foods low in saturated fats and high in fiber, and getting regular physical activity may help prevent high cholesterol and high blood pressure.

Unhealthy dietary choices also increase the risk of certain cancers. Highly processed foods and drinks are linked to an increased risk of at least 13 types of cancer. Moreover, eating red and processed meat has also been associated with developing colorectal cancer (Centers for Disease Control and Prevention, 2022).

Fortunately, eating a healthy diet can play a pivotal role in preventing, delaying, and managing chronic disease (Harvard T. H. Chan School of Public Health, 2017a). It is never too late to make positive changes to one's eating habits. Regardless of current dietary choices, adopting a healthy diet can have a significant impact on well-being and reduce the risk of chronic disease.

Section 4. Nutrition Education in the United States

Nutrition Education in US Public Schools

Healthy eating remains a challenge in America with obesity rates among children rising continually for more than 30 years (Board et al., 2013). Schools play an important role in helping students establish healthy eating behaviors, especially for younger children. Most eating habits are formed early in life, therefore, it is important that children receive the appropriate education in nutrition. Recognizing the influential role of schools in early habit formation in diet is crucial to addressing the evolving food environment within US public schools.

Notably, the school lunch and breakfast programs have become one of the major contributors to the health of students consuming school meals. A student who has school lunch daily would consume one-sixth of his or her meals each year in that setting, and a student who has both lunch and breakfast daily would consume one-third (Board et al., 2013). This is a huge percentage of a child's annual food intake. The health of the students can be greatly improved by what the school serves.

Furthermore, a child's food decisions encompass factors such as calories, fats, sugar, salt, vegetables, snacks, and portion choices which are often influenced by various sources including the media, their parents, and their peers (Board et al., 2013). However, the accuracy and relevance of this information can be questionable. To address the challenges of children's dietary decisions, nutrition education can be incorporated throughout the school curriculum in various ways. Nutrition education in the classroom, cafeteria, farm-to-school programs, and school gardens provides children with knowledge and skills to help them choose and consume healthy foods and beverages, empowering them to make better choices for their future.

However, nutrition is not being properly educated in US public schools. According to the CDC, US students receive less than 8 hours of required nutrition education each school year, which is far below the 40 to 50 hours that are needed to affect behavior change (Centers for Disease Control and Prevention, 2021a). Given the important role diet plays in preventing chronic disease and supporting good health, schools should strive to engage students in the education of nutrition and other healthy lifestyle choices. Nutrition education remains a vital component in promoting healthy eating and overall well-being for the future. To counteract the main contributors of poor eating and lack of adequate exercise, the emphasis on nutrition education stands as a crucial element in fostering positive lifestyle choices for the overall health of the next generation.

Nutrition Education Among Physicians

Physicians are often consulted by patients about their diets and other lifestyle habits. However, it may be surprising to realize the limited knowledge they often possess on the subject of nutrition. Doctors have historically received little to no nutrition training, restricting their ability to effectively talk to patients about this crucial aspect of health (Stanford School of Medicine, 2019). During four years of medical school, most students spend fewer than 25 hours on nutrition and only about one-fifth of American medical schools require students to take a nutrition course (Harvard T. H. Chan School of Public Health, 2017c).

Furthermore, there are several barriers that prevent effective dietary counseling. This is mostly due to the lack of time, insufficient knowledge and resources, and brief clinical visits. The US medical system focuses on treating illness rather than disease prevention, further acting as a barrier. Dietary modifications and lifestyle changes which are essential for disease prevention, typically involve a slow and steady approach rather than yielding faster results. Because of this, patients tend to revert back to previous behaviors, discouraging physicians from spending time to provide dietary education (Colino, 2016).

To address these challenges in patient care and dietary knowledge in physicians, it is imperative to make nutrition education mandatory in medical schools across the country. This will better equip doctors with the appropriate knowledge to provide patients with informed and effective dietary advice, bridging the gap in nutritional expertise within the medical profession.

Conclusion

Today, the world of food science and nutrition provides confusing and contradictory information, making it more challenging to make informed dietary choices. This paper reviewed the areas of nutrition and food science to understand the influence of these fields on the health of the United States population. By understanding the dynamics of food science and nutrition and spreading transparent science-based information, individuals can make informed dietary choices to reduce, manage, and delay chronic disease, and work towards a healthier and more sustainable future.

However, there are several limitations in nutrition research that challenge the understanding of nutrition in the public including research designs, the complexity of the food environment, and the approaches to collecting and analyzing data (Vitolins & Case, 2020). Data on food and people vary in many ways and the differences can significantly alter the outcomes of a scientific paper. Additionally, nutrition research results are often simplified and misinterpreted, causing more confusion in the public. It is also crucial to recognize that food science and nutrition are not just scientific fields with fixed answers; they continue to evolve and adapt to new research and discoveries.

Furthermore, it is important to consider multiple factors that contribute to the overall health of the population. Although diet is a matter of an individual's own choice, the environment in which they live can influence what they choose to eat. Many food environments make it challenging to eat a healthy diet, especially in lower-income areas where they lack access to healthy food choices. Therefore, it is essential to take action to promote awareness about people's dietary choices. This involves improving access to healthy, safe, and affordable foods; reducing the consumption of calorie-dense, nutrient-poor foods; and raising awareness about the importance of healthy eating by educating the public.

In conclusion, while many challenges can arise in the complexity of diet, nutrition, and food science, in both the field of scientific research and our daily lives, these can be overcome with a collective effort to improve the food systems and eating environments in the United States. The ultimate goal of this paper was to evaluate the changes in food science and the

nutrition landscape in the United States over the past half-century and make this information accessible to the public so that they can make healthier dietary choices. In a healthcare system that focuses primarily on treating diseases instead of preventing them, the emphasis on disease prevention with lifestyle changes is critical. The dietary choices people make matter, and everyone can create a positive impact by taking responsibility for their health and the health of their communities.

Acknowledgments

Works Cited

American Heart Association. (2015, March 20). *Portion Size Versus Serving Size*. American
Heart Association.
https://www.heart.org/en/healthy-living/healthy-eating/eat-smart/nutrition-basics/portion-
size-versus-serving-size

Better Health Channel. (2012). *Food processing and nutrition*. Better Health Channel.
https://www.betterhealth.vic.gov.au/health/healthyliving/food-processing-and-nutrition

Better Health Channel. (2022, January 13). *Protein*. Better Health Channel.
https://www.betterhealth.vic.gov.au/health/healthyliving/protein

Board, F. and N., Board on Children, Y., & Medicine, I. of. (2013). The Current Opportunity. In
www.ncbi.nlm.nih.gov. National Academies Press (US).
https://www.ncbi.nlm.nih.gov/books/NBK202124/

Carlson, J. L., Erickson, J. M., Lloyd, B. B., & Slavin, J. L. (2018). Health Effects and Sources
of Prebiotic Dietary Fiber. *Current Developments in Nutrition*, *2*(3).
https://doi.org/10.1093/cdn/nzy005

Center for Nutrition Policy and Promotion. (2011). *A Brief History of USDA Food Guides*.
Center for Nutrition Policy and Promotion.
https://myplate-prod.azureedge.us/sites/default/files/2020-12/ABriefHistoryOfUSDAFoo
dGuides.pdf

Centers for Disease Control and Prevention. (2019, September 19). *Food Labels | Eat Well with
Diabetes*. CDC. https://www.cdc.gov/diabetes/managing/eat-well/food-labels.html

Centers for Disease Control and Prevention. (2021a, February 15). *Nutrition Education in US
Schools* . Centers for Disease Control and Prevention.
https://www.cdc.gov/healthyschools/nutrition/school_nutrition_education.htm

Centers for Disease Control and Prevention. (2021b, March 19). *Healthy Eating for a Healthy
Weight*. Centers for Disease Control and Prevention.
https://www.cdc.gov/healthyweight/healthy_eating/index.html#:~:text=Emphasizes%20fr
uits%2C%20vegetables%2C%20whole%20grains

Centers for Disease Control and Prevention. (2022, September 8). *Poor nutrition*. CDC.
https://www.cdc.gov/chronicdisease/resources/publications/factsheets/nutrition.htm

Cleveland Clinic. (2014). *Carbohydrates*. Cleveland Clinic.
https://my.clevelandclinic.org/health/articles/15416-carbohydrates

Cleveland Clinic. (2019, April 25). *Fat and Calories*. Cleveland Clinic.
https://my.clevelandclinic.org/health/articles/4182-fat-and-calories

Cleveland Clinic. (2022, March 7). *Insulin: What Is It, How Do You Take It, Side Effects*.
Cleveland Clinic. https://my.clevelandclinic.org/health/articles/22601-insulin

Cleveland Clinic. (2023, March 23). *What Ultra-Processed Foods Are (and Why They're So Bad
for You)*. Healthessentials; Cleveland Clinic.
https://health.clevelandclinic.org/ultra-processed-foods/

Colino, S. (2016). *How Much Do Doctors Learn About Nutrition?* US News & World Report;

U.S. News & World Report.
https://health.usnews.com/wellness/food/articles/2016-12-07/how-much-do-doctors-learn
-about-nutrition

FDA. (2021). The Lows and Highs of Percent Daily Value on the New Nutrition Facts Label. *FDA*.
https://www.fda.gov/food/new-nutrition-facts-label/lows-and-highs-percent-daily-value-n
ew-nutrition-facts-label

FDA. (2023a). Calories on the Nutrition Facts Label. *FDA*.
https://www.google.com/url?q=https://www.fda.gov/food/new-nutrition-facts-label/calori
es-new-nutrition-facts-label&sa=D&source=docs&ust=1699154458583031&usg=AOvV
aw1SZNrkJj2s_UNJCFYbdc9q

FDA. (2023b). How to Understand and Use the Nutrition Facts Label. *FDA*.
https://www.fda.gov/food/nutrition-facts-label/how-understand-and-use-nutrition-facts-la
bel

Grigg, K. (n.d.). *LibGuides: Food and Nutrition through the 20th Century: Government
Guidelines*. Guides.lib.unc.edu; UNC University Libraries.
https://guides.lib.unc.edu/nutrition-history/government

Gropper, S. S. (2023). The Role of Nutrition in Chronic Disease. *Nutrients*, *15*(3), 664.
https://doi.org/10.3390/nu15030664

Harvard Health Publishing. (2020, October 1). *Stop counting calories*. Harvard Health.
https://www.health.harvard.edu/staying-healthy/stop-counting-calories

Harvard Health Publishing . (2023). *Nutrition*. Harvard Health.
https://www.health.harvard.edu/topics/nutrition#:~:text=Good%20nutrition%20helps%20
fuel%20your

Harvard T. H. Chan School Of Public Health. (2019). *Processed Foods and Health*. The
Nutrition Source; Harvard T. H. Chan School Of Public Health.
https://www.hsph.harvard.edu/nutritionsource/processed-foods/

Harvard T. H. Chan School of Public Health. (2012a, September 18). *What Should I Eat?* The
Nutrition Source. https://www.hsph.harvard.edu/nutritionsource/what-should-you-eat/

Harvard T. H. Chan School of Public Health. (2012b, October 29). *Food Marketing and
Labeling*. Obesity Prevention Source; Harvard T. H. Chan School of Public Health.
https://www.hsph.harvard.edu/obesity-prevention-source/obesity-prevention/food-enviro
nment/food-marketing-and-labeling-and-obesity-prevention/

Harvard T. H. Chan School of Public Health. (2016, July 25). *Simple Steps to Preventing
Diabetes*. The Nutrition Source.
https://www.hsph.harvard.edu/nutritionsource/disease-prevention/diabetes-prevention/pre
venting-diabetes-full-story/

Harvard T. H. Chan School of Public Health. (2017a, February 2). *Disease Prevention*. The
Nutrition Source; Harvard T. H. Chan School of Public Health.
https://www.hsph.harvard.edu/nutritionsource/disease-prevention/

Harvard T. H. Chan School of Public Health. (2017b, March 21). *Carbohydrates*. The Nutrition
Source; Harvard T. H. Chan School of Public Health.
https://www.hsph.harvard.edu/nutritionsource/carbohydrates/

Harvard T. H. Chan School of Public Health. (2017c, May 9). *Doctors need more nutrition
education*. News.
https://www.hsph.harvard.edu/news/hsph-in-the-news/doctors-nutrition-education/

Harvard T. H. Chan School of Public Health. (2018). *Types of Fat*. The Nutrition Source;
Harvard T. H. Chan School of Public Health.
https://www.hsph.harvard.edu/nutritionsource/what-should-you-eat/fats-and-cholesterol/t
ypes-of-fat/

Harvard T. H. Chan School of Public Health. (2020a, March 1). *Understanding triglycerides*.
Harvard Health. https://www.health.harvard.edu/heart-health/understanding-triglycerides

Harvard T. H. Chan School of Public Health. (2020b, September 23). *Precision Nutrition*. The
Nutrition Source.
https://www.hsph.harvard.edu/nutritionsource/precision-nutrition/#:~:text=Precision%20
nutrition%2C%20also%20referred%20to

Harvard T. H. Chan School of Public Health. (2021, June 29). *Understanding Food Labels*. The
Nutrition Source; Harvard T. H. Chan School of Public Health.
https://www.hsph.harvard.edu/nutritionsource/food-label-guide/

Harvard T. H. Chan School of Public Health. (2022a). *Protein*. The Nutrition Source; Harvard T.
H. Chan School of Public Health.
https://www.hsph.harvard.edu/nutritionsource/what-should-you-eat/protein/

Harvard T. H. Chan School of Public Health. (2022b, August). *Preventing Heart Disease*. The
Nutrition Source.
https://www.hsph.harvard.edu/nutritionsource/disease-prevention/cardiovascular-disease/
preventing-cvd/

Harvard T.H. Chan School of Public Health. (2012, September 18). *Fiber*. The Nutrition Source;
Harvard T.H. Chan School of Public Health.
https://www.hsph.harvard.edu/nutritionsource/carbohydrates/fiber/#:~:text=Fiber%20hel
ps%20regulate%20the%20body%27s

Jahns, L., Davis-Shaw, W., Lichtenstein, A. H., Murphy, S. P., Conrad, Z., & Nielsen, F. (2018).
The History and Future of Dietary Guidance in America. *Advances in Nutrition*, *9*(2),
136–147. https://doi.org/10.1093/advances/nmx025

LDN, C. S., MS, RD, CSO. (2021, March 10). *A look at the 2020–2025 Dietary Guidelines for
Americans*. Harvard Health.
https://www.health.harvard.edu/blog/a-look-at-the-2020-2025-dietary-guidelines-for-ame
ricans-2021031022098

Lustig, R. H. (2021). *Metabolical : the lure and the lies of processed food, nutrition, and modern
medicine*. Harperwave.

Martinho, V. J. P. D. (2020). Food Marketing as a Special Ingredient in Consumer Choices: The

Main Insights from Existing Literature. *Foods*, *9*(11), 1651.
https://doi.org/10.3390/foods9111651

Mayne, S. (2022). Improving Nutrition to Turn the Tide on Diet-Related Chronic Disease. *FDA*.
https://www.fda.gov/news-events/fda-voices/improving-nutrition-turn-tide-diet-related-chronic-disease

Mayo Clinic. (2022a, March 22). *Carbohydrates: How carbs fit into a healthy diet*. Mayo Clinic.
https://www.mayoclinic.org/healthy-lifestyle/nutrition-and-healthy-eating/in-depth/carbohydrates/art-20045705

Mayo Clinic. (2022b, November 4). *Dietary fiber: Essential for a healthy diet*. Mayo Clinic.
https://www.mayoclinic.org/healthy-lifestyle/nutrition-and-healthy-eating/in-depth/fiber/art-20043983

Mayo Clinic. (2023, February 15). *Dietary fat: Know Which to Choose*. Mayo Clinic.
https://www.mayoclinic.org/healthy-lifestyle/nutrition-and-healthy-eating/in-depth/fat/art-20045550

MedlinePlus. (2015). *Dietary fats explained: MedlinePlus Medical Encyclopedia*.
Medlineplus.gov; National Library of Medicine.
https://medlineplus.gov/ency/patientinstructions/000104.htm

Monroe-Lord, L., Harrison, E., Ardakani, A., Duan, X., Spechler, L., Jeffery, T. D., & Jackson, P.
(2023). Changes in Food Consumption Trends among American Adults since the
COVID-19 Pandemic. *Nutrients*, *15*(7), 1769. https://doi.org/10.3390/nu15071769

National Institute on Aging. (2022, February 24). *How To Read Food and Beverage Labels*.
National Institute on Aging.
https://www.nia.nih.gov/health/how-read-food-and-beverage-labels

National Library of Medicine. (2017, November 16). *Dietary Guidelines for Americans
Guidelines and Key Recommendations*. Www.ncbi.nlm.nih.gov; National Academies
Press (US).
https://www.google.com/url?q=https://www.ncbi.nlm.nih.gov/books/NBK469839/&sa=D
&source=docs&ust=1699156963906348&usg=AOvVaw39L1wsBC9ZigtwyDBNeygg

NYU School of Global Public Health. (2021, October 14). *Americans Are Eating More
Ultra-Processed Foods*. Www.nyu.edu; NYU.
https://www.nyu.edu/about/news-publications/news/2021/october/ultra-processed-foods.html

Osilla, E. V., & Sandeep Sharma. (2019, June 18). *Calories*. Nih.gov; StatPearls Publishing.
https://www.ncbi.nlm.nih.gov/books/NBK499909/

Osmosis from Elsevier. (2022, October 15). *How to read a nutrition facts label*.
Www.youtube.com.
https://www.youtube.com/watch?v=hzwnwLgmFOQ&feature=youtu.be

Parker, L., Annina Catherine Burns, & Sanchez, E. (2009). *Actions for Healthy Eating*. Nih.gov;
National Academies Press (US). https://www.ncbi.nlm.nih.gov/books/NBK219682/

Roberto, C., & Gorski, M. (2015). Public health policies to encourage healthy eating habits:

recent perspectives. *Journal of Healthcare Leadership*, *7*, 81.
https://doi.org/10.2147/jhl.s69188

Skjonsberg, L. (2014, November 24). *Understanding Calories*. HealthySD.gov.
https://healthysd.gov/understanding-calories/

Stanford School of Medicine. (2019, October 10). *Why Medical Schools Need to Focus More on Nutrition*. School of Medicine.
https://med.stanford.edu/school/leadership/dean/precision-health-in-the-news/why-medic
a-schools-need-focus-nutrition.html#:~:text=Doctors%20have%20historically%20receive
d%20almost

Stiepan, D. (2023, January 30). *Mayo Clinic Minute: Relationship between food, disease stronger than you may think*. Mayo Clinic News Network; Mayo Clinic.
https://newsnetwork.mayoclinic.org/discussion/mayo-clinic-minute-mayo-clinic-minute-r
elationship-between-food-disease-stronger-than-you-may-think/

Symbols, I. of M. (US) C. on E. of F.-P. N. R. S. and, Wartella, E. A., Lichtenstein, A. H., & Boon, C. S. (2010). Overview of Health and Diet in America. In *www.ncbi.nlm.nih.gov*. National Academies Press (US).
https://www.ncbi.nlm.nih.gov/books/NBK209844/#:~:text=The%20poor%20diets%20an
d%20sedentary

United States Department of Agriculture. (2020). *Dietary Guidelines for Americans 2020 -2025* .
https://www.dietaryguidelines.gov/sites/default/files/2020-12/Dietary_Guidelines_for_A
mericans_2020-2025.pdf

University of Auckland. (n.d.). *Food Science and Nutrition - The University of Auckland*.
Www.auckland.ac.nz. Retrieved November 5, 2023, from
https://www.auckland.ac.nz/en/study/study-options/find-a-study-option/food-science.html

Vitolins, M. Z., & Case, T. L. (2020). What Makes Nutrition Research So Difficult to Conduct and Interpret? *Diabetes Spectrum*, *33*(2), 113–117. https://doi.org/10.2337/ds19-0077

Walker, C. (2015). *The Effects of an American Diet on Health - Inquiro - Journal of Undergrad Research | UAB*. Www.uab.edu; Inquiro - Journal of Undergrad Research | UAB.
https://www.uab.edu/inquiro/issues/past-issues/volume-9/the-effects-of-an-american-diet-
on-health

Wempen, K. (2022, April 29). *Are you getting too much protein?* Mayo Clinic Health System; Mayo Clinic.
https://www.mayoclinichealthsystem.org/hometown-health/speaking-of-health/are-you-g
etting-too-much-protein

World Health Organization. (2021). *Healthy Diet*. World Health Organization.
https://www.who.int/initiatives/behealthy/healthy-diet

World Health Organization. (2023). *Malnutrition*. Www.who.int.
https://www.who.int/health-topics/malnutrition

Strategies for Sustainable Small Business Growth During Economic Recession By Yastremskiy Artemiy and Kenbayev Alen

Abstract

This study assesses management strategies for small businesses during periods of economic stability and recession, with a focus on approaches that ensure sustainable development and prosperity in times of economic crisis. The uniqueness of this research lies in the evaluation of proposed strategies through case studies of firms engaged in socially responsible business practices. The primary methodology employed includes statistical data analysis and financial forecasting through a pre-trained AI model.

Findings indicate that the recommended strategies, encompassing diversified loan options, financial indicator analysis and interpretation, and effective supplier and customer relationship management, positively influence long-term business success. The AI model's projections suggest that businesses implementing the advised strategy experienced a 19% growth two years post-recession, indicating a pathway to stable and sustainable future growth. The study underscores the importance of a comprehensive understanding of a company's financial health and the implementation of measures to promote its long-term sustainability and growth.

Keywords

Small business, recession, economic downturn, business sustainability, financial management.

Introduction

In today's economic paradigm, small businesses play a key role, being not only a major source of innovation and entrepreneurial activity but also a significant driver of job creation and social stability. Despite their importance, small businesses often face several significant challenges, including vulnerability to economic fluctuations and low levels of awareness, making them particularly vulnerable during economic downturns. These periods can significantly hamper operations, limit access to financial resources, and reduce consumer demand, all of which harm their survivability and ability to grow.

Relevance

In the current economic environment, with most macroeconomic indicators pointing to an approaching recession, the lack of awareness among small businesses of the economic challenges ahead is becoming a particularly acute problem. Many small businesses may not have sufficient resources or knowledge to adequately interpret and respond to complex economic signals, exacerbating their vulnerability.

Problematics

In times of economic downturn, small businesses face particular challenges that make their situation more difficult than that of larger companies. Reduced consumer spending leads to lower profits, forcing businesses to take cost-cutting measures, which can limit their ability to innovate and grow. The credit crunch exacerbates this problem by limiting access to necessary financing and making cash flow more difficult to manage, increasing the risk of bankruptcy. These factors underscore the importance of supporting and adapting small businesses in the face of economic uncertainty and their key role in maintaining economic stability and job creation.

Goals

To develop a comprehensive approach to small business development in the context of economic instability, which involves a deep understanding of market dynamics, analysis of successful practices, and development of recommendations to help small businesses become more resilient to external shocks.

Definition and role of small business

Small businesses in the U.S., defined by specific criteria set by the Small Business Administration (SBA), such as having fewer than 500 employees and meeting certain annual revenue thresholds, are fundamental to the country's economic landscape. They constitute 99.9% of all businesses in the nation and are responsible for employing 46.4% of the U.S. workforce (Statista, 2023). These enterprises are pivotal in fostering innovation, driving economic growth by introducing new products and services, and significantly contributing to job creation. Over recent decades, small businesses have been credited with generating a substantial portion of new jobs, underscoring their role not only in reducing unemployment but also in enhancing the vibrancy and diversity of the American economy. Their impact extends beyond mere numbers, influencing local communities and the broader economic ecosystem through a dynamic mix of products, services, and entrepreneurial spirit (Michigan University Library, 2022).

What is a recession and how to define it

Recessions, a phase within economic cycles, are characterized by a decline in activities such as GDP growth, employment, consumer spending, and business investment. These cycles fluctuate between expansion and contraction, with recessions marking the downturn period. A recession is typically signaled by a sustained decline in GDP over two or more quarters, among other indicators (IMF, 2021).

Key indicators to identify recessions include real personal income excluding transfers, reflecting consumer financial health; nonfarm employment, representing a significant portion of the workforce contributing to GDP; real retail sales, indicating consumer spending trends; and industrial production, measuring manufacturing and industrial activity levels. These metrics are crucial for assessing the economy's state, pinpointing recessionary trends, and guiding timely interventions to mitigate negative impacts, ensuring a more comprehensive understanding and response to economic downturns (The White House, 2021).

Impact on a Small Business

During economic downturns, small businesses encounter significant hurdles, primarily due to a decline in consumer spending, restricted access to credit, and disruptions in supply chains. These challenges are intensified by the financial difficulties of suppliers and customers, resulting in delayed payments and exacerbating cash flow problems. The 2008 financial crisis vividly demonstrated the compounded effects of these issues, placing many small businesses in a precarious position and at a higher risk of bankruptcy. The profound impact of economic recessions on small enterprises underscores the essential need for effective support and flexible strategies to ensure their survival and growth, highlighting their indispensable role in fostering job creation, innovation, and overall economic resilience (Federal Reserve Bank of New York, 2019).

Methodology

This methodology covers the following key steps: case study analysis, collection of financial and macroeconomic data, use of AI for modeling and forecasting, and analysis of forecasting results. These phases aim to test and analyze strategies to increase the sustainability of small businesses.

Case study analysis

This stage involves studying and analyzing successful case studies of companies that have previously implemented similar resilience strategies in the face of economic instability. The aim is to identify key success factors and possible obstacles.

Financial and macroeconomic data collection

Macroeconomic data, particularly statistics from the 2007-2009 recession in the United States, are used for analysis. This data helps in modeling the conditions under which sustainability strategies can be applied and their potential impact on small businesses. Average data on the financial performance of small businesses in the U.S. from the VBSR organization was also obtained.

Using AI for modeling

A pre-trained AI model is used to simulate the potential development of small businesses based on financial indicators including financial statements and the country's macroeconomic situation. The model allows the evaluation of possible development scenarios and the effectiveness of different sustainability strategies.

Analysis of forecasting results

Based on the obtained data and modeling results, analysis of the success of strategies for small businesses. This stage includes an assessment of the effectiveness of the applied strategies

and their contribution to improving the resilience of small businesses in the context of economic instability.

The goal of the methodology is to comprehensively evaluate the effectiveness of the identified steps to increase small business resilience by analyzing real company cases and modeling potential scenario development using AI. This will make it possible not only to understand which strategies are most effective but also how they can be adapted and applied in different conditions.

Saving account

One of the most important factors in ensuring the safety and sustainability of a company is having a savings account. A savings account is a sum of money set aside and used only in emergencies, such as an economic downturn, natural disaster, loss of a business partner, and so on, which distinguishes it from ordinary savings accounts. Other times, this cushion can save a company from bankruptcy and help it get through tough times more easily.

Saving accounts directly affects the sustainability of a company. Having a sufficient cash reserve directly influences a company's sustainability, providing a buffer to navigate economic downturns or unexpected market changes without external funding, thus managing debt. An emergency fund equips a company with additional financial reserves to handle surprises, such as loss of investor support, without resorting to asset sales or costly loans, crucial during borrowing challenges in recessions. This fund enhances financial stability.

Furthermore, an emergency fund allows strategic opportunities during economic downturns, like acquiring assets at favorable prices. It also boosts the company's reputation as financially robust, attracting investors and enhancing customer and partner trust, thereby contributing to long-term success and sustainability. Financially sound companies are likely to secure loans under better terms.

Creating an emergency fund involves analyzing necessary expenses, especially since economic downturns necessitate cutting non-essential spending. Entrepreneurs should prioritize establishing an emergency fund, saving a fixed income percentage, and adjustable in profitable months. The fund should cover 3-6 months of operating expenses, calculated from the yearly and last quarter's average expenses for accuracy, ensuring readiness for company growth and expense increases.

Emergency funds must be stored safely, avoiding risky investments like the stock market, as they are crucial for the company's future. Opting for high-yield savings accounts in reputable banks offers secure, accessible storage. Distributing funds across multiple banks, with individual deposits not exceeding $250,000, ensures insurance coverage and minimizes risk.

Maintaining pre-recession prices during downturns can attract customers seeking affordability, potentially increasing market share despite short-term losses from production cost increases. Supporting these strategies with slightly increased emergency fund contributions can help maintain the customer base and market share, underlining the emergency fund's role in ensuring business resilience and growth potential.

Work with suppliers

In these volatile times, maintaining good relationships and diversifying suppliers are important strategies to prepare for a possible recession and to ensure the sustainability of the company.

During economic downturns, there is a significant decrease in consumer demand, which can cause a decrease in an organization's revenues and profits. However, companies that have a stable supplier base will be better able to cope with financial difficulties and overcome a period of economic instability.

Supplier diversification is an integral strategy for a company's sustainability. When a company is dependent on a single supplier, it becomes more vulnerable to possible changes such as deterioration in the quality of goods or services, price increases, and delayed, or even discontinued deliveries. In this case, the company can become stranded and lose customers, reputation, and profitability.

Supplier diversification helps spread risk and minimize a company's vulnerability. Supplier diversity provides choice and can also lead to improved quality of goods and services as the company can compare and monitor the options available. Supplier diversification encourages balanced cooperation with several partners, which can increase the flexibility, efficiency, and sustainability of the company.

It is important to understand how to select the most suitable suppliers, the criteria may vary from one circumstance to another, but in any case, these are worth paying attention to. Firstly, the supplier should guarantee the quality and reliability of the products provided. Secondly, you need to consider the value of money. Thirdly, the supplier's company should be financially sound, with strong cash flow and good creditworthiness. Finally, the supplier should be open to communication and constructive dialog. And also the global goal of your company should match with the supplier's goal, for easier relationship building.

Maintaining a good relationship with suppliers contributes to the sustainable and long-term development of the company, because a trusting relationship with suppliers brings a number of serious benefits, among them getting more favorable terms and deferrals. As well as a stable supply from their side, which increases the company's chances of future growth. Then there is a reasonable question of how to build them, which we will try to answer below.

First of all, it is important to maintain regular communication. Keep in touch with your suppliers. Think about what is working well and discuss areas for improvement.

Being able to give feedback, can be a boost to both companies. if misunderstandings arise, be calm and straightforward so that the situation does not escalate

Despite good planning, mistakes and misunderstandings can happen. It is important to address these with your supplier in a professional manner.

It is important to be able to get in the supplier's position. Respect their way of doing things and make it easy for them by following the arrangements you have made. Think about

what you like about your customers and do the same for your suppliers. Just as you do your best to take care of a good customer, so will your suppliers if you are that for them.

Once you have established a trusting relationship with your supplier and do not doubt him in the slightest, it is worth thinking about the prospects for further cooperation. In order to build them as effectively as possible, it is worth considering the option of concluding long-term mutually beneficial contracts. This can help lower prices, and receive various bonuses and privileges from the supplier.

Recession-resistant customers

Recession-resistant customers are companies that are less dependent on economic fluctuations and are able to operate successfully even during periods of economic downturn. Here are some examples of such clients:

Large corporations. Large companies with sustainable social responsibility programs often remain customers of socially responsible suppliers during periods of recession. These companies can stick to their commitment to supporting sustainable partners to preserve their reputation.

Government organizations and non-profit organizations: Government and non-profit sectors often continue to invest in socially responsible projects regardless of the economic situation. They can be repeat clients, especially if such projects address important social and environmental issues.

Educational institutions and research organizations: These organizations usually continue to operate regardless of economic fluctuations and may be interested in collaborating with socially responsible businesses to conduct research and educational projects.

It is important to note that no company can be completely recession-proof, as an economic downturn affects the entire market. However, some companies engaged in socially responsible business may have an advantage over others due to increased interest in their products and services even during periods of economic instability.

The presence of such customers can play a very important, if not decisive, role in shaping the resilience of the company as a whole. During a recession, they will be able to provide entrepreneurs with almost guaranteed income, which is obviously not unreasonable during an economic downturn.

Companies should try to find recession-resistant customers, and the options for finding and then building relationships with them will vary depending on the situation.

Real-World Examples

SAP, a renowned software company, has established itself as a leader in social responsibility and sustainability. It actively implements sustainability principles not only in its internal operations but also in the products and services it offers to customers. A key aspect of this strategy is its collaboration with large corporations and government agencies, which allows

SAP to showcase its technological innovations while increasing the understanding and application of sustainable practices across industries.

SAP offers software solutions to corporate customers to help them manage their carbon footprint, energy efficiency, and supply chain optimization, thereby promoting environmentally responsible behavior and reducing costs. An important factor in the company's sustainability development is its work with governments; it includes offering solutions for urban and public resource management, which improves the efficiency of public administration and enhances the quality of life of citizens. This collaboration not only promotes sustainability in these sectors but also helps the company with its own sustainability, as governments are often recession-resistant customers, it also provides the company with new opportunities for innovation and growth.

In its sustainability reports, SAP demonstrates not only its achievements in reducing its carbon footprint and improving energy efficiency but also its contribution to global social and environmental issues. Through collaboration with sustainable customers, SAP continually updates and adapts its products and services, resulting in continuous innovation and maintaining the company's reputation as a leader in sustainable technology and software.

Avoid short-term solutions

It is very important to make the right decisions to form a sustainable company. First of all, it is necessary to determine the global goals of the company and act strictly based on them. Therefore, the decision-making process should not be based on short-term advantages, but on global business objectives. Short-term decisions can hurt the long-term strategy of the company. If a company's management makes decisions based only on immediate results and does not consider potential long-term consequences, it can lead to missed opportunities for growth and development. Long-term decisions may not look profitable at the time they are made, but over time they pay off many times over. Short-term decisions have clear advantages at the moment, but later they can lead to a loss. As an example, the sale of company assets to cover expenses or debts, at first this option looks interesting, but then it turns out that the sale of assets has reduced the company's potential for future growth and development. These gains may turn out to be short-term illusions when the company discovers that it no longer has the resources and capabilities that would have been necessary for competitiveness and future success. Long-term solutions, on the other hand, may require more effort and financial investment in the beginning, but they can create a sustainable platform for long-term profits and sustained growth that will ultimately yield many more benefits than instant solutions.

One of the best ways to make good and strategically beneficial decisions is bottom-up decision-making. This method involves the fact that local managers will be involved in the decision-making process. This strategy is justified by the fact that local managers are more aware of the situation and state of affairs in their department, thus the decisions they make will be more correct in a particular situation. However, this does not mean that the management will not be aware of the situation during the decision-making process, it just gives additional authority to the more knowledgeable employees. As an example of this situation, in a chain of stores A, product

B is in demand, but in one particular location, visitors are not interested in buying product B, but they really like product C. Despite this, the management of the chain of stores A, taking advantage of the general statistics supplies goods B to this point, thus the potential profit of this store is not realized. If its manager were responsible for supplies to this outlet, he would take into account the demand for product C.

Work with employers

Personnel plays a crucial role in the success of any business, as employees are responsible for realizing the company's goals. The effectiveness with which staff performs their duties directly influences the future success of the enterprise. Therefore, selecting a good team and managing it effectively are essential for productive work and achieving the company's objectives. To build an effective team, it is important to increase employee motivation, possibly through a bonus program where employees receive rewards for actions such as completing transactions successfully. Maintaining trust and fostering friendly relationships among employees is also key; this can be achieved through team building and events that allow employees to connect on a personal level, thereby improving overall team motivation and attitude. Hiring a dedicated person to organize such events could be beneficial.

Ensuring that the entire team understands the company's global goals is vital so that their decisions align with the company's best interests, thereby enhancing decision-making quality and effectiveness. Additionally, allowing employees to adapt their working hours to their personal circumstances through flexible scheduling can significantly impact productivity and work quality. Implementing programs to support work-life balance, such as offering extra days off for physical and mental health restoration, is also advisable.

Before a recession, it is critical for a company to address overstaffing, characterized by having more employees than necessary for efficient and productive business operations. This excess can arise from various factors, including business model changes, decreased product or service demand, process automation, or shifting economic conditions. Managing this involves job cuts or redeploying employees within the company. Identifying overstaffing requires analyzing operation and business process aspects, such as low productivity, employee utilization, market segment headcount comparisons, benchmarking, and process analysis. These measures can reduce cash outflow and aid in refining the company's goals and strategies. Reducing redundant staff under favorable financial conditions allows affected individuals to recover, emphasizing the importance of strategic workforce management.

Real-World Examples

TOMS Shoes, founded by Blake Majkoski in 2006, has revolutionized the concept of social entrepreneurship with its unique one-for-one model. Under this model, the company commits to donating a pair of shoes to children in need for every pair sold. This initiative has been widely recognized and supported for its contribution to charity and social entrepreneurship.

Notably, TOMS Shoes has expanded its charity model to include not only shoes but also other products. For example, for every pair of sunglasses sold, the company provides medical

care, surgery, treatment, or eyeglasses to improve vision for people in need. This move shows the company's deep commitment to social responsibility and its desire to make a positive impact on the lives of people around the world.

TOMS Shoes also has a strong culture of corporate social responsibility within the company. The company has created an environment where every employee feels a sense of ownership of the larger mission and involvement in the firm's unique social purpose. This not only improves employee productivity but also strengthens team spirit and corporate culture.

In addition, TOMS Shoes actively encourages its employees to participate in charitable projects. This includes both direct participation in charitable events and supporting initiatives aimed at improving living conditions in vulnerable communities. This approach not only raises employee awareness of social issues but also helps to create deeper and more meaningful engagement between the company and employees.

TOMS Shoes will demonstrate that a company can be successful not only from a financial point of view but also make a meaningful contribution to the public good, which makes it a shining example of successful social entrepreneurship and shows competently conducted work with personnel.

Financial Statement

Gaining a deep understanding of a company's financial health is crucial for managing its operations, making informed decisions, and strategizing for future growth. The foundation of this understanding rests on the analysis of three core financial statements: the balance sheet, income statement, and cash flow statement. These documents collectively offer a comprehensive view of a company's financial status, beyond mere income and expense figures. They help in evaluating the company's debt levels, liquidity, operational efficiency, and overall financial sustainability, particularly crucial during economic downturns.

The balance sheet presents a detailed snapshot of a company's financial condition at a specific point in time, including assets, liabilities, and shareholders' equity. It is instrumental in calculating various financial ratios that gauge the company's health, such as the Debt-to-Equity Ratio, and serves as a vital document for securing financing or investment by demonstrating the company's creditworthiness and financial stability.

The income statement, or profit and loss statement, offers a detailed account of the company's revenues, expenses, and profits over a certain period, providing insights into its operational efficiency and profitability. This statement is particularly useful for identifying trends in financial performance, areas for cost reduction, and opportunities for revenue enhancement. It supports strategic planning by allowing business owners to evaluate the effectiveness of their strategies and make adjustments as needed.

The cash flow statement tracks the movement of cash into and out of the business, highlighting the company's ability to generate cash to meet its obligations, invest in new opportunities, and maintain operational stability. It is essential for understanding the liquidity of the business and its capability to sustain operations and grow. A negative cash flow, especially in

the context of investment activities, can sometimes indicate strategic acquisitions or investments aimed at future profitability, rather than financial distress.

Regular, in-depth analysis of these financial statements, complemented by key financial metrics such as EBITDA, the Current Ratio, and the Debt-to-Equity Ratio, is indispensable. It allows entrepreneurs to pinpoint the company's financial strengths and weaknesses, identify non-essential expenses that can be eliminated, and uncover areas where investments are not yielding expected returns. This disciplined approach to the financial analysis not only aids in navigating through challenging economic conditions but also positions the company for sustained growth and long-term success.

Moreover, exploring additional financial indicators enriches the analytical framework, offering a more nuanced understanding of the company's operational and financial health. This enables management to make well-informed decisions, ensuring the company's resilience and competitiveness in the marketplace.

Cash flow replenishing

During an economic downturn, a business may encounter a deficit of liquid funds, which can have severe consequences. Herein, we propose strategies to bolster the company's monetary inflow.

Small business borrowing during a recession can make strategic sense and have an important impact on a company's cash flow. In such a context, small businesses face several financial challenges such as reduced cash flow, cash on hand, and consumer demand, and not every company has the capacity to deal with these challenges. In this situation, one of the possible ways to generate cash is to take a loan to keep the company afloat.
Borrowing money will solve cash flow problems and cash shortages in the following ways:

Fulfilling the company's obligations. In times of economic downturn, borrowers are reluctant to give out loans and demand the already given money back. To keep a good credit rating and not be in a bad situation, it is important for the company to fulfill its obligations on time. In addition, besides financial organizations, suppliers will also demand payment, perhaps even harder, as they are also subject to recession. In addition, paying suppliers on time is strategically important as it will help maintain a better relationship with the supplier.

Avoiding the problem of the possibility of a cash flow gap. Not every business has built recession-proof customer relationships. As the economy is in decline, the company's customers are also experiencing the full effect of the recession, which can cause delays in payment on the predicted due date. Because of this, the possibility of a cash flow gap increases manifold, which can be devastating for the company.

Covering operating expenses. During a recession, a company must continue to operate; no one can cancel operating expenses. Just like before the recession, owners have to pay employee salaries, taxes, logistics costs, rent, and marketing costs. All of this requires cash, which may not be available in tough times.

Capitalize on the opportunities for the company created by the recession. During an economic downturn, a huge number of businesses will go bankrupt, reducing competition in the industry. This can be a good opportunity to scale and increase the market share of your business, which may require additional funds.

One possible way to solve these problems is to borrow money. We have highlighted some interesting, and most importantly, effective ways to get cash

SBA loans. The U.S. Small Business Administration helps small businesses get financing by setting loan guidelines and reducing lender risk. These SBA-backed loans make it easier for small businesses to get the financing they need, ranging from $500 to $5.5 million. SBA does not make loans directly to entrepreneurs - instead, loans are made by SBA-approved lenders, such as traditional banks and microlending institutions. The 7(a) loan is SBA's flagship product. Borrowers can obtain financing to cover most business goals, such as working capital and real estate purchases. The SBA guarantees up to 90% for all 7(a) loans. Repayment terms are up to 25 years. We have identified the following pros of SBA lending:

The SBA offers types of loans that cater to a variety of business needs. They also have some temporary loan programs designed to address specific problems. Such as SBA 7(A), SBA Express, SBA 504, CAPLines Program, Export Loan, Micro Loan Program, and Disaster Loan.

Credit cards

During a recession, entrepreneurs can take advantage of opportunities offered by banks, such as interest-free periods on credit cards. This method of obtaining funds is one-time and can be used to cover expenses.

This method is good because the amount of money is quite easy and quick to get. I would like to emphasize the fact that if you meet the deadline allocated by the bank to repay the debt, the interest rate will be close to zero.

But at the same time, this is not a way to get cash, the money from the credit card can be used to cover operating expenses. We would like to note that the amount is not large at all. These are the disadvantages of this method.

Factoring

Factors are intermediaries that provide cash or credit by buying the receivables of companies. Factors are essentially funding sources that pay companies the amount of their invoices minus a commission. Factoring can help companies meet their short-term cash needs by selling their accounts receivable in exchange for a cash infusion from the factoring company. Pros of factoring:

The most important benefit of factoring is that it provides your company with immediate cash.

Invoice factoring is easier to obtain than most loans. The basic requirement is that you have invoices for work delivered that are paid for by creditworthy customers.

Most conventional loans, such as lines of credit and loans, require significant assets as collateral. Factoring is different in that it only requires invoices as collateral.

For all its advantages, factoring has some disadvantages. These disadvantages can be minor or major, depending on what you want for your business.

Even though factoring is a form of debtor-in-possession financing, you still have to pay interest on the money you "borrow" with factoring.

Not every business owner likes to hand over control of their customer relationships. A business may not feel comfortable with another organization taking on this role, especially if the customer relationship is handled uniquely. Another disadvantage may be the cost of factoring, which can be higher than the cost of a conventional loan.

Credit Cooperative

A credit cooperative is a financial institution established to provide financial services to its members, who are usually its owners or members. The main principle of credit cooperatives is mutual assistance and mutual support of their members in the area of financial needs. This includes finances by lending to each other.

Credit cooperatives operate under a unique model that emphasizes membership, where individuals or businesses with shared interests, such as common industry or community goals, come together to access financial services. These cooperatives are member-owned and managed, meaning that each member has a say in key management decisions, ensuring that the operations align closely with the members' needs and preferences.

The range of financial services provided by credit cooperatives includes loans, savings options, and various other financial products, all designed to meet the specific financial requirements of their members. Unlike traditional commercial banks that aim to maximize profits for shareholders, credit cooperatives prioritize the financial well-being of their members. This mutualistic approach often results in more favorable terms for loans and savings, including lower interest rates on loans and potentially higher returns on savings, directly benefiting the members.

For small businesses and entrepreneurs, credit cooperatives represent a vital source of support. They offer access to finance that might be otherwise unavailable or prohibitively expensive when sought through commercial banks. This can include virtually interest-free loans or loans on significantly more favorable terms, providing the essential capital that small businesses need for growth and development. Furthermore, credit cooperatives offer a suite of banking services such as current accounts, payment and transfer services, and deposits, which can greatly enhance a company's financial stability and help manage cash flow effectively.

In addition to traditional financial services, some credit cooperatives and suppliers may engage in agreements where loans are provided in exchange for a commitment to a long-term relationship. This arrangement benefits both parties: the company secures a loan on favorable terms along with a reliable supplier relationship, while the supplier gains a guaranteed stable income over the contract period.

During economic recessions, credit cooperatives' role becomes even more critical. They provide a buffer for small businesses against financial instability, offering solutions tailored to sustaining operations through challenging times. Furthermore, businesses can adopt strategies to bolster cash flow and customer loyalty, such as introducing budget-friendly product options and incentivizing repeat business with discount programs for recycling or returning packaging.

In summary, credit cooperatives offer a member-centric financial ecosystem that supports small businesses through access to tailored financial services, fostering growth, stability, and resilience, especially during economic downturns. The cooperative model and strategic partnerships with suppliers, coupled with innovative customer engagement strategies, can provide a solid foundation for navigating financial challenges and seizing growth opportunities.

Secure Access to External Funding

We highly recommend that small business owners look into government funding and grant programs. A winning grant can provide secure access to outside funding and capital on very favorable terms. Speaking of the socially responsible business industry, the following funding programs are worth considering:

Small Business Community Capital SBCC provides flexible, customized debt solutions and junior capital to small and medium-sized businesses in the U.S. that generate at least $1 million in EBITDA.

Community Development Financial Institutions (CDFI) Fund: The CDFI Fund supports community financing, including socially responsible businesses, through a variety of programs and investments in financial institutions operating in underserved areas.

AI model analysis

To evaluate the strategy, we developed a Python-based AI model that simulates the impact of a recession on a fictional company, Green Inc. that sells eco-friendly household products in the United States. Our model uses standard financial statements: cash flow statement (table 1), income statement (table 2), and balance sheet (table 3) to create basic information about the company's operations and integrate economic indicators to simulate recessionary conditions. We applied quantitative analysis and predictive modeling using historical data and industry averages to simulate various stress scenarios and assess Green Inc.'s resilience to adverse economic conditions.

The AI model can analyze revenue fluctuations, cost management efficiency, asset liquidity, and the stability of the company's capital structure in a recession. This identifies vulnerabilities and strengths in the company's strategy, suggesting strategic adjustments to improve resilience. The model provides practically meaningful data for strategic decision-making, serving as a model for similar businesses seeking to adapt to economic downturns.

We have placed the company in a severe recession, unemployment has reached 10%, US GDP has contracted by 4.3%, and US inflation has reached 3.8%. Many companies experienced deteriorating creditworthiness, for example, bankruptcies in the U.S. increased 74% in 2009

compared to 2007, retail sales in the U.S. decreased 8.6%, and the savings rate in the U.S. increased from 2.6% to 5.6% in 2009.

This company has applied this resilience strategy, our model shows that the company should easily survive the recession and even emerge from it with a 19% gain over the next two years.

Summary

This study confirms that an integrated approach to financial, resource, and human asset management is the key to a company's resilience in economic instability. The application of a savings account strategy, effective supplier relationships, focus on long-term goals and strategic human resource management allow the company to not only survive periods of recession but also utilize these periods for development and expansion. Green Inc.'s AI model-based analysis of 19% growth two years after the recession proves the validity of this comprehensive approach.

Conclusion

In conclusion, this study offers a comprehensive analysis of small business management strategies during periods of economic stability and recession, emphasizing the importance of sustainability and adaptability in the face of economic challenges. The study emphasizes the key role of small businesses in the economy, contributing significantly to innovation, job creation, and social stability. However, their vulnerability to economic downturns requires implementing strategic measures to ensure sustainability and growth.

The results of this study show that a multifaceted approach that includes financial management, strategic planning, and building relationships with suppliers and customers significantly enhances the long-term success of small businesses. Utilizing a variety of loan options, properly analyzing financial performance, and developing strong relationships with suppliers and customers are identified as key strategies that positively impact business sustainability.

The application of these strategies, validated by case studies and using a pre-trained AI model for financial forecasting, demonstrates a promising path for small businesses to weather economic recessions effectively. AI model predictions indicating 19% growth for businesses adopting the recommended strategies two years after the recession provide empirical evidence of the effectiveness of these approaches.

Moreover, the study emphasizes the importance of maintaining a forward-looking perspective focused on long-term sustainability rather than short-term gains. This includes building a solid savings foundation, prudent financial management, and cultivating recession-resistant client relationships. In addition, the study highlights the critical need for small businesses to remain agile, adapting their business models and strategies to changing market conditions to capitalize on new growth opportunities.

Work Cited

Longenecker, J. G., Petty, J. W., Palich, L. E., & Hoy, F. (n.d.). *Small Business Management*.

National Bureau of Economic Research. (n.d.). *Business cycle dating*.
https://www.nber.org/research/business-cycle-dating#:~:text=The%20NBER's%20definiti on%20emphasizes%20that,and%20duration%E2%80%94as%20somewhat%20interchan geable

MIT Sloan Management Review. (n.d.). *Preparing your company for the next recession*.
https://shop.sloanreview.mit.edu/store/preparing-your-company-for-the-next-recession

U.S. Small Business Administration. (n.d.). *504 loans*.
https://www.sba.gov/funding-programs/loans/504-loans

Alternative Business Funding. (n.d.). *How to protect your business and survive a recession*.
https://www.alternativebusinessfunding.co.uk/knowledge/surviving-a-recession/how-to-p rotect-your-business-and-survive-a-recession/

Pearce, J. A., & Michael, S. C. (1997). Marketing strategies that make entrepreneurial firms recession-resistant. *Journal of Business Venturing, 12*(4), 301–314.
https://doi.org/10.1016/s0883-9026(97)89449-9

Çivi, E. (2013). Marketing strategies to survive in a recession. *International Journal of Business and Emerging Markets, 5*(3), 254. https://doi.org/10.1504/IJBEM.2013.054930

Dechow, P. M., Kothari, S., & Watts, R. L. (1998). The relation between earnings and cash flows. *Journal of Accounting and Economics, 25*(2), 133–168.
https://doi.org/10.1016/s0165-4101(98)00020-2

Finance & Development. (2012, February 1). *Finance & Development*.
https://www.imf.org/external/pubs/ft/fandd/basics/recess.htm

Exploring Perspectives of Climate Change and Causes of Eco-Anxiety in High School Students By Susanna Denny

Acknowledgments

Abstract

The behavioral implications of climate change are of the utmost importance as threats to the environment grow increasingly potent. Eco-anxiety and environmentalism are two phenomena that provide valuable insight to the contemporary relationship between humans and the environment. This study sought to address two main topics: (1) the manifestation of environmental awareness as pro-environmental action and (2) the impact of select factors on eco-anxiety. Both have been explored with high school samples to concentrate on teenage perspectives. Based on the findings of Soares et al. (2021) and Wang et al. (2023), I expected that participants who were more aware of environmental issues would have engaged in more sustainable habits than those less aware. Furthermore, I hypothesized that greater empathy and sustainability would result in higher eco-anxiety compared to general anxiety. I obtained my data via Google Forms surveys that were sent out to high school students at Sacred Heart Academy and nearby high schools. Phase 1 additionally collected qualitative data from experimental groups, which aided the understanding of the younger generation's views on climate change. My results support a correlation between high environmental knowledge and higher sustainability that was addressed in previous research. I also found that, while neither general anxiety nor empathy was found to have a significant impact on eco-anxiety, sustainability did significantly impact eco-anxiety with an r^2 value of 0.221 (p < .001).

Introduction

The behavioral implications of climate change are of the utmost importance as threats to the environment caused by human activity grow increasingly potent. It is imperative to understand how people react to ecological changes. Thus, eco-anxiety and environmentalism are two phenomena that may provide valuable insight to the contemporary relationship between humans and the environment.

Eco-anxiety is defined as "a set of responses ranging from normal reactions to environmental threats to more overwhelmed states that impair daily functioning" (Wang et al., 2023, p. 5). It has been increasingly observed in younger generations and is typically coupled with a pessimistic view of the environment's future; however, eco-anxiety is also a part of the broader trend toward deterioration in mental health (Hickman et al., 2021). This stands in communion with a heightened awareness of climate change in younger age groups (Barrón, 2022). While eco-anxiety may cause feelings of paralysis and helplessness in the face of the

climate crisis, education and open discussions have been found to provide an antidote (Wang et al., 2023). This is supported by a case study conducted by educators at Northern Arizona University, in which professors implemented climate discussions about ecocomposition, environmental justice, contributions of Indigenous peoples, and urban effects of climate change into course curricula (Barrón et al., 2022). Barrón et al. (2022) found that university students were more motivated to engage sustainably and propose creative climate action after these tailored classroom experiences. Furthermore, an international survey of eco-anxiety concluded that the ecological stress of participants in all four countries examined could be considered an accurate indicator of higher engagement in sustainable behaviors (Tam et al., 2023).

Environmental awareness is not only a conspicuous indicator of eco-anxiety, but also helps to predict one's engagement in pro-environmental behaviors (Soares et al., 2021). A byproduct of this research was a call for improved education on environmental threats, particularly relating to the implications of plastic pollution on human health. Much of the environmental action considered in Soares et al. (2021) related to participants' engagement in the business sector as consumers of plastic products. Environmental sustainability was also measured in undergraduate students in Thailand and connects knowledge and perceptions of sustainability to intentions toward sustainability (Fuchs, 2022). The survey results are viewed as a possible mode of educational reform regarding ecological sustainability.

Personal motivations for sustainability are complex, yet empathy is rarely considered as a relevant factor for environmental engagement. Its potential in the argument for sustainability is addressed in the scope of ocean health, as it is recognized as an internal motivator that is based on knowledge associated with environmental conservation efforts (Kim & Cooke, 2021). Thus, it was concluded that empathy led to higher perceived sustainability. Empathy has also been associated with greater focus on environmental representation in the media. This, in turn, may influence behavioral intentions to be more sustainable via lifestyle choices.

This study sought to address two main topics: (1) the manifestation of environmental awareness as pro-environmental action and (2) the impact of select factors on eco-anxiety. Both have been explored with high school samples to concentrate on teenage perspectives. Based on the findings of Soares et al. (2021) and Wang et al. (2023), I expected that participants who were more aware of environmental issues would have engaged in more sustainable habits than those less aware. Furthermore, I hypothesized that, compared to the effect of general anxiety on eco-anxiety, greater empathy and sustainability would result in higher eco-anxiety.

I obtained my data via Google Forms surveys that were distributed to high school students at Sacred Heart Academy and nearby high schools. Phase 1 additionally collected qualitative data from experimental groups, which aided the understanding of the younger generation's views on climate change.

Methods

SAMPLE: PHASE 1

Figure 1

Ethnic Breakdown of Participants

Ethnicities*	Percentage from Sacred Heart Academy	Percentage from Other Schools
Asian or Asian-American	8.2%	26.8%
Black or African-American	11.5%	4.8%
Hispanic or Latino	13.1%	0%
Non-Hispanic White	73.8%	71.4%
Indigenous	1.6%	0%
Mixed**	1.6%	0%

*The total does not equal 100% to account for students of multiple ethnicities
**Mixed refers to students who self-reported to be of multiple ethnic backgrounds, but did not specify

Figure 2

Grade Level Breakdown of Participants

Grade Level	Percentage from Sacred Heart Academy	Percentage from Other Schools
9th	16.4%	23.8%
10th	19.7%	0%
11th	45.9%	76.2%
12th	18.0%	0%

I conducted my study primarily on-campus at Sacred Heart Academy, a private Catholic high school in a suburban neighborhood (see Figures 1 and 2). I began collecting data on October 25, 2022, and ended on March 2, 2023.

A quasi-random sample of students from Sacred Heart were asked to complete a preliminary survey on environmental knowledge. The survey was also distributed to students from other high schools in the surrounding area (See Figure 2). Of the 85 total participants, 61 were enrolled at Sacred Heart, while 24 attended other nearby schools. Confidentiality was maintained throughout. Student ID numbers (Sacred Heart students) and the last 4 digits of the responder's phone number (other schools) were recorded, as participants' information was needed in case any individual wished to void his or her results at a later date. Informed consent from participants and a custodial parent or guardian was obtained prior to administration of the

surveys. Subjects were also given contact information for me, my advisor, and a school-affiliated mental health professional.

The preliminary survey included questions from Soares et al. (2021), measuring the environmental awareness and environmental engagement of participants. Answer choices were adjusted to "yes," "no," and "maybe" to reduce the time required to complete the survey. I also included an optional space to clarify why "maybe" had been selected for any of the background knowledge questions. This allowed qualitative data to be further explored in the discussion. Sacred Heart students were invited to participate in the experimental portion of my study. This involved either 1) reading material that would be e-mailed to them at a later date (Experimental Group 1) or 2) joining me for an in-person interview (Experimental Group 2). All Sacred Heart participants were later sent the link to a follow-up survey of my own design.

The 13 participants in Experimental Group 1 received one of three different material options that would constitute as scientific education on environmental issues: "(Micro)plastic crisis: Un-ignorable contribution to global greenhouse gas emissions and climate change" (Shen et al., 2020), "A Review on the Causes, Effects and Mitigation of Climate Changes on the Environmental Aspects" (Nda et al., 2018), and "Greenwashing – fake green/environmental marketing" (Lukinović & Jovanović, 2019). I met with the 15 members of Experimental Group 2 for one-on-one interviews (one subject was interviewed via Google Meet, while the others were interviewed in-person). In these meetings, I inquired about the participant's perceptions of, and experiences with, climate change (see Appendix A). For participants in the in-person interviews, emails were sent to the address corresponding to the student ID number to schedule a time to meet. All conferences were held privately and within the high school building. The students' ID numbers were the only identifiers included in the records kept of these interviews.

A follow-up survey was sent to all participants who had completed the preliminary survey. Student ID numbers were collected to match responses with those to the original survey. The experimental groups were asked to reflect on what they learned (see Appendix B).

The preliminary environmental awareness survey was scored with "yes" as two points, "maybe" as one point, and "no" as zero points. Participants' points were tallied to achieve their overall score. Those who scored 0-26 of 52 were considered to have low background knowledge, and those who scored 27 to 52 were considered to have high background knowledge. Self-reported behaviors were scored on a scale of 0 to 20, where a score of 0 represents no engagement in sustainable behavior, and a score of 20 indicates participation in all eco-friendly behaviors suggested. A T-Test Calculator for Two Independent Means was employed to test for any significance of the relationship between background knowledge and sustainable engagement.

Figure 3

Ethnic Breakdown of Participants

Ethnicities	Percentage from Sacred Heart Academy*
Asian or Asian-American	5.7%
Black or African-American	11.5%
Hispanic or Latino	11.5%
Non-Hispanic White	71.2%

Figure 4

Grade Level Breakdown of Participants

Grade Level	Percentage from Sacred Heart Academy*
9th	26.9%
10th	23.1%
11th	23.1%
12th	26.9%

*The total does not equal 100% due to rounding

Phase 2 of my study was conducted on the campus of Sacred Heart Academy. I used Google Forms to create my survey and recorded and sorted all data using Google Sheets. The survey opened on September 22, 2023, and closed on September 29, 2023. All participants were students at Sacred Heart Academy (see Figures 3 and 4). There were 53 total respondents to the survey, but one response was eliminated due to incomplete data. Thus, 52 surveys were used in data analysis. Results were collected anonymously. The last four digits of participants' phone numbers were recorded in case later withdrawal from the study was requested. Consent of the participants, or of a parent or guardian if the participant was under 18, was obtained prior to starting the survey. The contact information for me, my research mentor, the head of the science department at my school, and the school's social worker were included on the form. Participation was voluntary and uncompensated.

I compiled a quasi-random sample with participants from my school community, whom I gathered by asking my research mentor to distribute it to students in his classes. Additionally, I shared the survey link and description to several general subject teachers. All four grade levels were roughly balanced in data representation (see Figure 4).

The objective of my study was to identify the impact of general anxiety, empathy, and sustainability on eco-anxiety. I developed a Google Form survey with four parts. The first was a short form State Trait Anxiety Index (see Appendix C), which I obtained from my research mentor, Dr. Sullivan (available through Open Access). The second was an adapted form of the State Trait Anxiety Index. I altered the wording to apply specifically to eco-anxiety (see Appendix D). The third was an empathy assessment, also found in the public domain. Permission is found in Lietz et al. (2011). The fourth was a sustainability index, in the public domain, as per Fuchs (2022).

All data was recorded in Google Sheets. Three separate simple linear regressions were used to identify the impact of general anxiety, empathy, and sustainability on eco-anxiety.
Results
PHASE 1

Figure 5
Sustainable Behavior Scores as a Function of Environmental Awareness Scores for Participants from Sacred Heart Academy
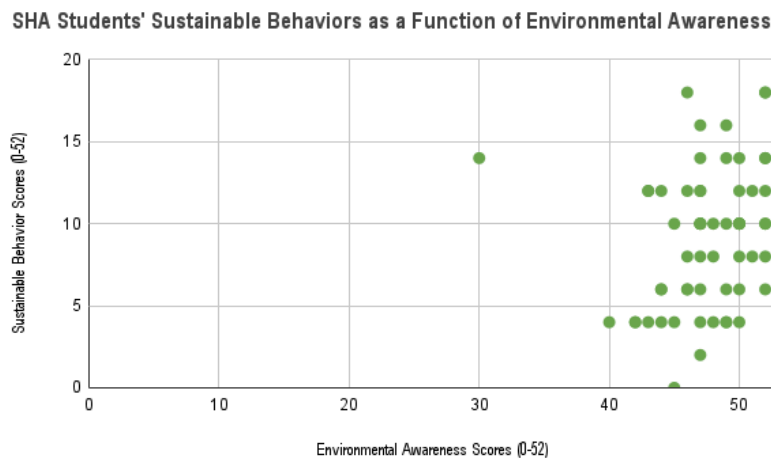
I had hypothesized that students with high background knowledge would be more engaged in eco-friendly behaviors; however, there was no significant difference between the practices of the low-knowledge (calculated mean of 8.19) and high-knowledge (calculated mean of 10.19) groups (T-value = -1.952; $p > .05$) (see Figure 5).

Figure 6

Average Environmental Awareness Scores of Participants from Sacred Heart versus Other Schools

Average Environmental Awareness Scores of Sacred Heart Students vs. Non-Sacred Heart Students

Sacred Heart: 47.5
Other: 44.1
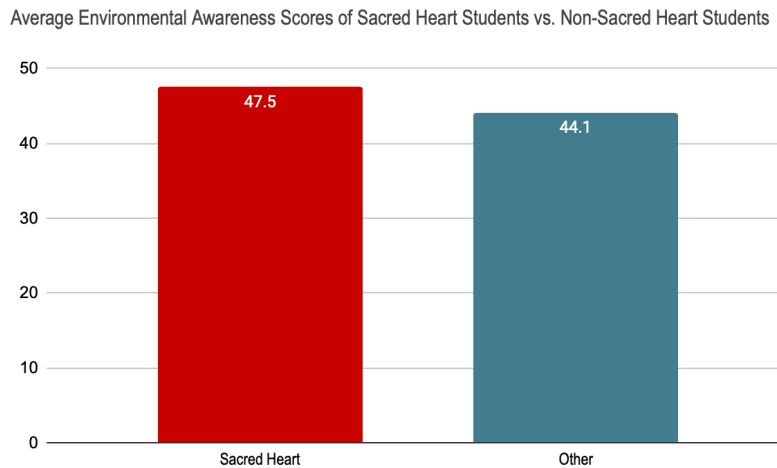
Compared to students from nearby schools, Sacred Heart students were found to have a higher background knowledge (T-value = 3.422; $p < .001$) (see Figure 6). If a participant selected "maybe" in response to an environmental awareness question, he or she was asked to give a short explanation as to why a "yes" or "no" would not suffice. 63.1% of the time, the participant would indicate "I don't know" or "I'm not sure" as the reasoning.

Figure 7

Average Sustainable Behavior Scores of Participants from Sacred Heart versus Other Schools

Average Sustainable Behavior Scores of Sacred Heart Students vs. Non-Sacred Heart Students

Sacred Heart: 9.2
Other: 6.6
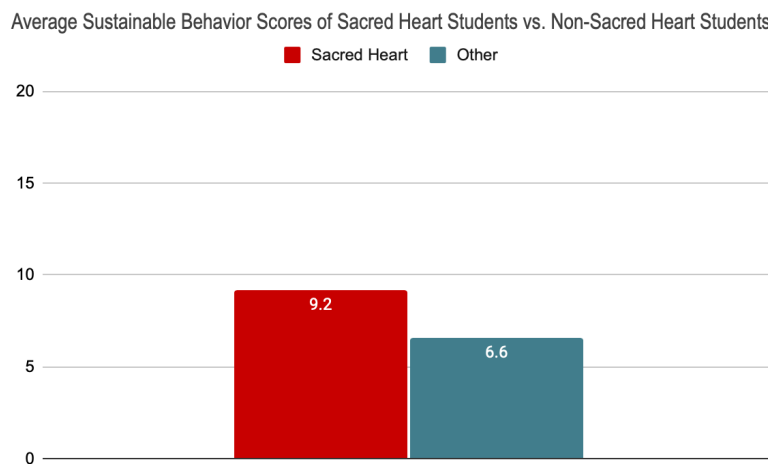
Sacred Heart students also had a greater participation in sustainable behaviors (T-value = 2.656, $p < .01$) (see Figure 7).

All 15 members of Experimental Group 2 were aware of climate change and its existence. Of those, 9 reported that they were not satisfied with governmental efforts to address

climate change, and 3 more said that the political sphere could be trying harder to make a change.

Of the 23 participants of Experimental Groups 1 and 2 that responded to the exit survey, 54.5% said that their opinions on climate change had been altered as a result of being exposed to new information about environmental issues; 65.2% agreed that they felt inspired to continue learning about the environment and to live more sustainably. Over half (58%) of the 31 respondents to the exit survey reported considering entering into an environmental field in the future. 77.4% rated the quality of environmental education that they had received (up to and including high school) as a 5 or lower out of 10, whereas 83.9% considered climate change to be an urgent concern, at 8 or higher out of 10.

PHASE 2

Neither general anxiety (calculated mean of 14.635; $p > .05$) nor empathy (calculated mean of 73.692, $p > .05$) was found to have a significant impact on eco-anxiety (calculated mean of 16.077 – see Figure 8). Sustainability (calculated mean of 99.904) significantly impacted eco-anxiety with an r^2 value of 0.221. Eco-anxiety as a function of sustainability yielded a t-value of 3.771 and a p-value of <.001.

Figure 8

Mean Eco-Anxiety Scores (see Appendix D)

Question Number	Mean Score (Raw)	Positively or Negatively Scored[3]	Mean Score (Used)
1	2.08	Negatively	2.92
2	2.69	Positively	2.69
3	2.42	Positively	2.42
4	2.73	Negatively	2.25
5	2.17	Negatively	2.81
6	2.96	Positively	2.96

Following the data seen in Figure 8, the average eco-anxiety score was 16.08, which is 67.0% of the maximum score for eco-anxiety, 24.

Discussion

My results in Phase 1 aligned with those of Soares et al. (2021), which found that higher knowledge of general plastic pollution and impacts of plastic pollution suggested a higher engagement in pro-environmental behaviors. The three most frequent sustainable behaviors supported by my data, reducing plastic use (49.2%, 58.3%[4]), recycling (93.4%, 70.8%), and using proper dispensary receptacles on the beach (82%, 41.7%) were also the most commonly reported behaviors in Soares et al. (2021). A further comparison of my results with those of Soares et al. (2021) is not feasible, as they take into account demographic factors that were not explored in my study. Moreover, my study features a qualitative perspective that is not considered in their inspection.

It was the recommendation of Soares et al. (2021) that environmental education be employed to mitigate plastic pollution. Based on my results, I agree that environmental education is very likely to increase awareness of ecological threats and therefore promote sustainable behaviors; however, my qualitative analysis shows a greater need for instruction on how to live more sustainably. In the defense for environmental education stands the 83.6% of students from my school and 91.7% of students from other schools who identified one of their motivations for taking pro-environmental action as being "educated about the consequences of not doing so." While my research has led me to support their call for a more intensive inculcation of the reality

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[3] The Eco-Anxiety Questionnaire was reverse scored. Positive-scored responses (from 1-4) corresponded with higher eco-anxiety and added to a participant's final score. Negative-scored responses (from 1-4) corresponded with lower eco-anxiety and were inverted before being added to the final score (i.e., $1 \rightarrow 4$, $2 \rightarrow 3$, etc.).

[4] The second value is representative of the second environmental awareness survey I distributed. The first was answered by students at my high school, which the first percentage value corresponds to, and the second is from the external survey I sent out, and the appropriate percent aligns with that group.

of climate change and what is predicted for the future of the environment, I do not believe that this alone will cause more youth to engage in ecological living. Instead, my study has led me to conclude that the main factor preventing high school students from engaging more sustainably is a lack of understanding of these practices.

A correlation between environmental education and environmental behavior was found in my study, but the two could not be proven to have a causal relationship. I credit this to the fact that many high school students are not knowledgeable on what a sustainable lifestyle would look like. For example, I questioned interviewees on whether they believed that their sustainable actions were the full extent of their capabilities. Out of the 15 students interviewed in Experimental Group 2, 13 commented that, while they were making continuous efforts to be environmentally friendly, they could "definitely be doing more." Furthermore, from the introductory survey responses of students at my school, 41% remarked that they are willing to engage in more sustainable activities, but they "don't know how to." An additional 29.5% agreed that they "don't have adequate information" on sustainability. Among students from various other schools, 41.7% and 16.7% reported the same, respectively.

Similar results were found in the research of Ann Bostrom and her colleagues (2018). In surveys distributed across the United States, the team sought to explore perceptions of climate change and action against it. They discovered that participants were not able to distinguish more effective behaviors from those that were not as impactful (Bostrom et al., 2018). While they, too, identified motivations in their participants to mitigate environmental threats, there was discord among these individuals on what courses of action were both attainable and effective. This was also reflected in the results of my research in Phase 1, which support a lack of general understanding regarding the ability of an individual to modify persisting climate issues.

Another testimony to the lack of understanding of environmental action lies in the work of Tam et al. (2023). In their investigation of the impact of eco-anxiety on individuals' perceptions of climate change, they claim that eco-anxiety is helpful and perhaps the more sane response to the state of climate affairs: "There were some demographic correlates of climate change anxiety, but the pattern was not always consistent across the countries. Climate change anxiety was positively associated with engagement in climate action in all four countries, but apparently more so for sustainable diet and climate activism than resource conservation and support for climate policy" (Tam et al., 2023, p. 1). The results of Phase 2 of my study, which identified sustainability as a cause of eco-anxiety, additionally support these findings.

Eco-anxiety is vital to the larger conversation on perceptions of climate change beyond its potential as a motivator for sustainable engagement, however. As eco-anxiety is a more recent phenomenon, there is less research about its effects on the human psyche. Wang et al. (2023) established that eco-anxiety can describe responses to climate that range from mild to severe. My exploration of eco-anxiety in high school students did not account for socioeconomic factors due to my limited sample size. Tam et al. (2023) supports the larger notion that those who are more vulnerable to the disastrous effects of global warming will experience heightened environmental

anxiety. Future research may further investigate the effects of eco-anxiety on a person's general well-being.

Limitations

My demographics were reflective of the student population at Sacred Heart Academy, in that the majority of my participants were White and of a similar religious and social background (i.e., Catholic and upper middle class). I addressed this in Phase 1 by surveying nearby high school students to compare background knowledge and environmental engagement, but my overall sample size was still rather low. I had 85 participants in Phase 1 and 52 in Phase 2. Additionally, participation was optional, so those who elected to participate might have been more aware of climate change than the average high school student.

Conclusion

This study explored high school students' perspectives and understandings of climate change, and how this background knowledge shapes their inclination to engage in sustainable behaviors. It also examined possible causes of eco-anxiety in high school students. My first hypothesis was ultimately not proven, since environmental awareness was not found to have a significant impact on environmental behaviors and not enough students reported their participation in sustainable action to have been positively impacted by exposure to educational resources to confirm a causational relationship. Regardless, the importance for education on climate change remains, along with a newly supported need for instruction in sustainability. My participants presented a strong affinity for the environment, such as a high percentage considering environmental careers in the future. This is key to understanding younger perspectives on climate change, as it reflects their willingness to work toward a larger climate solution.

Environmental sustainability is a cause of eco-anxiety, yet there are other factors that were not identified by the present study. Prior research has suggested that eco-anxiety prompts sustainable behavior and may help to alleviate anxiousness in regard to the environment. Future research may endeavor to prove causality between a greater environmental awareness and increased eco-anxiety. A proper understanding of this relationship, if any, would allow climate advocates to approach environmental education in a way best suited toward their audience. This may lead to more positive engagement of younger participants within the climate activism sector.

Works Cited

Barrón, N. G., Gruber, S., & Huffman, G. (2022). Student engagement and environmental awareness: Gen Z and ecocomposition. Environmental Humanities, 14(1), 219-232. https://doi.org/10.1215/22011919-9481528

Bostrom, A., Hayes, H. L., & Crosman, K. M. (2018). Efficacy, action and support for reducing climate change risks. Risk Analysis, 39(4), 805-828. https://doi.org/10.1111/risa.13210.

Fuchs, K. (2022). Survey dataset for the perceived consciousness towards environmental sustainability by undergraduate students. Data in Brief, 41(107985). https://doi.org/10.1016/j.dib.2022.107985.

Hickman, C., Marks, E., Pihkala, P., Clayton, S., Lewandowski, R. E., Mayall, E. E., Wray, B., Mellor, C., & van Susteren, L. (2021). Climate anxiety in children and young people and their beliefs about government responses to climate change: A global survey. Lancet Planet Health 5(12), E863-E873. https://doi.org/10.1016/S2542-5196(21)00278-3.

Kim, S. C., & Cooke, S. L. (2021). Using the health belief model to explore the impact of environmental empathy on behavioral intentions to protect ocean health. Environment and Behavior, 53(8), 811-836. https://doi.org/10.1177/0013916520932637.

Lietz, C. A., Gerdes, K. E., Sun, F., Geiger, J. M., Wagaman, M. A., & Segal, E. A. (2011). The empathy assessment index (EAI): A confirmatory factor analysis of a multidimensional model of empathy. Journal of the Society for Social Work and Research, 2(2). https://www.journals.uchicago.edu/doi/10.5243/jsswr.2011.6.

Lukinović, M., & Jovanović, L. (2019). Greenwashing – fake green/environmental marketing. Fundamental and Applied Researches in Practice of Leading Scientific Schools, 33(3), 15-17. https://doi.org/10.33531/farplss.2019.3.04.

Nda, M., Adnan, M. S., Abdullahi Ahmad, K., Usman, N., Razi, M., & Daud, Z. (2018). A review on the causes, effects and mitigation of climate changes on the environmental aspects. International Journal of Integrated Engineering, 10(4), 169-175. https://doi.org/10.30880/ijie.2018.10.04.027.

Shen, M., Huang, W., Chen, M., Song, B. Zeng, G., & Zhang, Y. (2020). (Micro)plastic crisis: Un-ignorable contribution to global greenhouse gas emissions and climate change. Journal of Cleaner Production, 254. https://doi.org/10.1016/j.jclepro.2020.120138.

Soares, J., Miguel, I., Venâncio, C., Lopes, I., & Oliveira, M. (2021). Public views on plastic pollution: Knowledge, perceived impacts, and pro-environmental behaviours. Journal of Hazardous Materials, 412. https://doi.org/10.1016/j.jhazmat.2021.125227.

Tam, K., Chan, H., & Clayton, S. (2023). Climate change anxiety in China, India, Japan, and the United States. Journal of Environment Psychology, 87, 1-14. https://doi.org/10.1016/j.jenvp.2023.101991.

Wang, H., Safer, D. L., Cosentino, M., Cooper, R., VanSusteren, L., Coren, E., Nosek, G., Lertzman, R., Sutton, S. (2023). Coping with eco-anxiety: An interdisciplinary perspective for collective learning and strategic communication. The Journal of Climate Change and Health. https://doi.org/10.1016/j.joclim.2023.100211.

The effect of the War in Ukraine on Food prices in the UK through its impact on Farmers' factors of production By Aditya Lonkar

Introduction

On February 24, 2022, the Russian president Vladimir Putin sanctioned a special military operation to invade part of a largely unprepared Ukraine[1].

The war had devastating impacts in Ukraine as well as an unprecedented and somewhat unforeseen effect on the UK. Among advanced economies, including Russia, the UK was the only country to suffer a contraction to its economy[2].

Nothing has exemplified these unforeseen impacts more than the UK food prices rising at their fastest rate in nearly 40 years[3]. It is known that the war in Ukraine has put increased pressure on farmers' factors of production resulting in increased prices of food on shelves. However, farming in the UK is not simple; farmers face a range of deeply rooted problems concerning every part of their factors of production. Understanding the extent to which the war in Ukraine and the multitude of past factors impacted farms will help in preparing them for the future.

Rationale:

Agriculture as a topic has always surrounded stories between my grandfather and me. My grandfather used to manage the food security of a state in India. Growing up, I always used to listen to stories of the real challenges faced by farmers who worked hard to maintain the food security of hundreds of thousands of people.

Now more than ever in this increasingly interconnected world, the base of society has often been left to the footnotes. It is important to stress that without farmers the global economy as a whole would grind to a halt[4]. Now I see the stories being displayed in front of me. I find the pressures farmers are facing in the UK and the stress that inevitably affects consumers increasingly worrying. To address the issues confronting farmers, we have to recognise the wide range of impacts they face such as the war in Ukraine, the UK leaving the EU, and the pandemic, as well as the extent to which they affect farmers. Thus, to what extent was the war in Ukraine responsible for increasing food prices in the UKthrough its impact on farmer's factors of production.

Methodology:

In order to find the true impact of the war in Ukraine on farmers' factors of production in the UK -land, labour, enterprise and capital-, I had to analyse secondary sources of data in UK government reports (documented by the Houses of Parliament), covering base restrictions, trade barriers, imports and exports and food inflation rates.

The data from the UK government is comprehensive and detailed due to the structured methods of exploration- whole departments dedicated to the retrieval of this data. As well as accurate and reliable due to the scrutiny from independent researchers and information organisations.

However, it may not present the plethora of pressures farmers have faced, affecting their factors of production, in the past five years: from monetary, the overall decrease (year on year) in subsidies; psychological, the burden of farming as a career; as well as uncontrollable variables such as average temperature rises. While Journalist outlets can provide these sources of data through their first-hand investigations, it may not be reported to the public under the same scrutiny placed on government released data and their discussion of the impact may be skewed in favour of extremes. Furthermore, in order to get a more appreciated view of the effect on farmers in the UK, I approached the Food, Farming and Countryside Commission, an organisation in close contact with farmers across the nation, for their view on the foremost impacts on UK farming. Analysing these data sources against the increase in food prices will help to understand the extent of the different impacts farmers face to their factors of production as a result of pressures in the past 5 years. I will use relevant economic theory and graphs to analyse and interpret the data I have gathered to infer the extent of impacts on farmers' factors of production and the extent to which the war in Ukraine was the primary factor of increased food prices.

Timeline

Impacts on farmers, especially in costs of production, can lead to an inflation of food prices. These increases lead to cost-push inflation of food prices. This occurs due to supply side factors resulting in higher costs of production.

The consumer price index (CPI) measures the average price increase from month to month for a basket of 700 different goods and services purchased by typical households. A subset of this is the food price inflation which measures increase in food prices.

Using a timeline of the food price inflation, a subset of overall inflation, will help in analysing the extent to which different factors influenced food prices through the impacts on farmers' factors of production.

Annual Consumer Price Index (CPI) Inflation
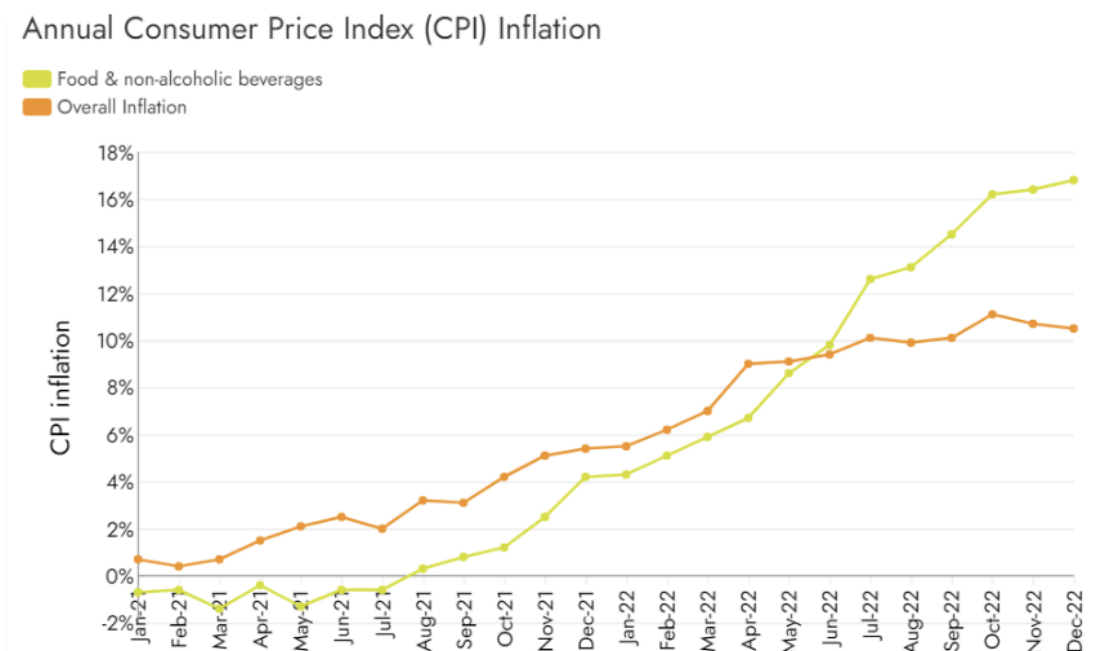
Economic analysis Labour

The UK relies heavily on immigration to supply their workforce in farming: less than 4% of seasonal workers come from the UK[6].

A labour shortage in farming has existed before the war in Ukraine. Both the UK leaving the European Union[7] and the Covid-19 pandemic[8] caused more difficult migration for potential workers. There has been reduced access to EU temporary workers with up to 75% of labour access being cut, leading to a shortage of 80,000 workers[9]. In August 2021, the government estimated that there were 500,000 vacancies out of 4.1 million roles in the food and farming sector.[10]

This has only grown worse. 67% of temporary seasonal workers who worked from April 2020 to March 2022 were from Ukraine[11]. Due to the adoption of martial law, they were prevented from leaving their country[12].

In 2022, these factors have culminated to 86% of farms being unable to fill their roles in arable, livestock, dairy and horticulture[13].

The underemployment in the agricultural sector is exacerbated by the nature of the work. Farmers face a higher risk of mental health issues and suicide due to 'work-related and contextual factors causing stress'[14]. Furthermore, in modern society there is stigma attached to the job of farming: many young people regard it as low wage work for the uneducated[15].This discourages potential new recruits and leads them to seek alternative jobs in higher paying and safer industries.

This results in an ageing workforce[16],with the average age of a labourer being 59 years old[17], causing a drop in the efficiency of the labourer in physical work compared to a younger counterpart.

In order to retain staff, farms have had to increase wages by an average of 5.4% in 2022, to make the job more attractive. Some farms had to increase wages by more than 10% to compete with other estates to retain their employees.[1]

Farmers increase wages from the equilibrium at W1Q1 to W2 in order to increase the quantity of employees from Q1 to Q2. However, after year-on-year decreases in agricultural workers, the 5.4% average wage increase only accounted for a 1.3% average increase in the workforce[19].

Economic theory suggests that an increase in wages will lead to a similar increase in employees. However, due to external factors, such as the nature of the job as well as disruptions to the flow of workers, the increase in wages scarcely maintains the already existing shortfall of labour in the agricultural sector. Over the past five years, the agricultural sector has had an overall decrease in the total workforce, quantity[20].

The impacts of farms failing to attract workers is devastating. In June 2022, £60 million of food was wasted on farms. This occurred due to labour shortages resulting in a majority of farmers reporting that production had fallen by almost a fifth on average[21]. Furthermore, the

quality of an ageing workforce puts pressure on the efficiency of production, combined with an ineffective increase in wages puts pressure on their extremely thin profit margins: a cereal farmer spends 9.03p on a loaf of bread while they only make 0.09p in profit[22].

Increasing wages would have meant an increase in input costs for farms. Moreover, a decline in the production rate due to the strain on employment in the agricultural sector would have meant decreased efficiency. An increase in input costs and decrease in overall efficiency would have contributed to an inflation of the food price, which in June 2022 had surpassed the overall inflation rate of 9%.[23]<1>

Enterprise and Capital

Farming revenue is dependent on factors beyond a farmer's control: the climate, pests and market stability. Subsidies help to ensure a stable revenue source for farms, by providing a safety net.

In the UK, farmers receive guaranteed direct payments depending on how much land they farm. These farming subsidies ensure revenue, especially after uncontrollable factors, such as climate change, affect a farm's margins. This comes in the form of direct income payments, through the 'Basic Payment Scheme' [24]. In 2020, the average per hectare subsidy was £280.

For many years, British farmers have been reliant on the Basic Payment Scheme, a requirement of the EU Common agricultural policy[25], for their direct income payments as subsidies.

However, since the UK left the EU on 31 January 2020[26], the Basic Payment Scheme has been reinvented into an environmental scheme, farmers are paid for environmental benefits rather than the land they use. The UK government started heavily cutting the direct income payments annually to save government spending and replace it with the environmental scheme. At the start of 2022, it was 20% less and in 2023 it was 35% less.[27]

However, the new environmental scheme has been slow to roll out, with only 1,980 of the 100,000 farmers successfully applied. Furthermore, the scheme pays as little as £22 per hectare for soil conservation. [28]

While farmers have become accustomed to the Basic Payment Scheme, the value of these subsidies have been declining year on year, replaced with a scheme that is currently underwhelming and underutilised.

Effect of Reduction of Subsidy on Price and Output of Food

Price of food

S3 – No Subsidy

S2 – Subsidy rate 2022
S1 – Subsidy rate 2020

P3

P2
P1

D

Figure 3

Q3   Q2 Q1

*Output of food
from UK farms*
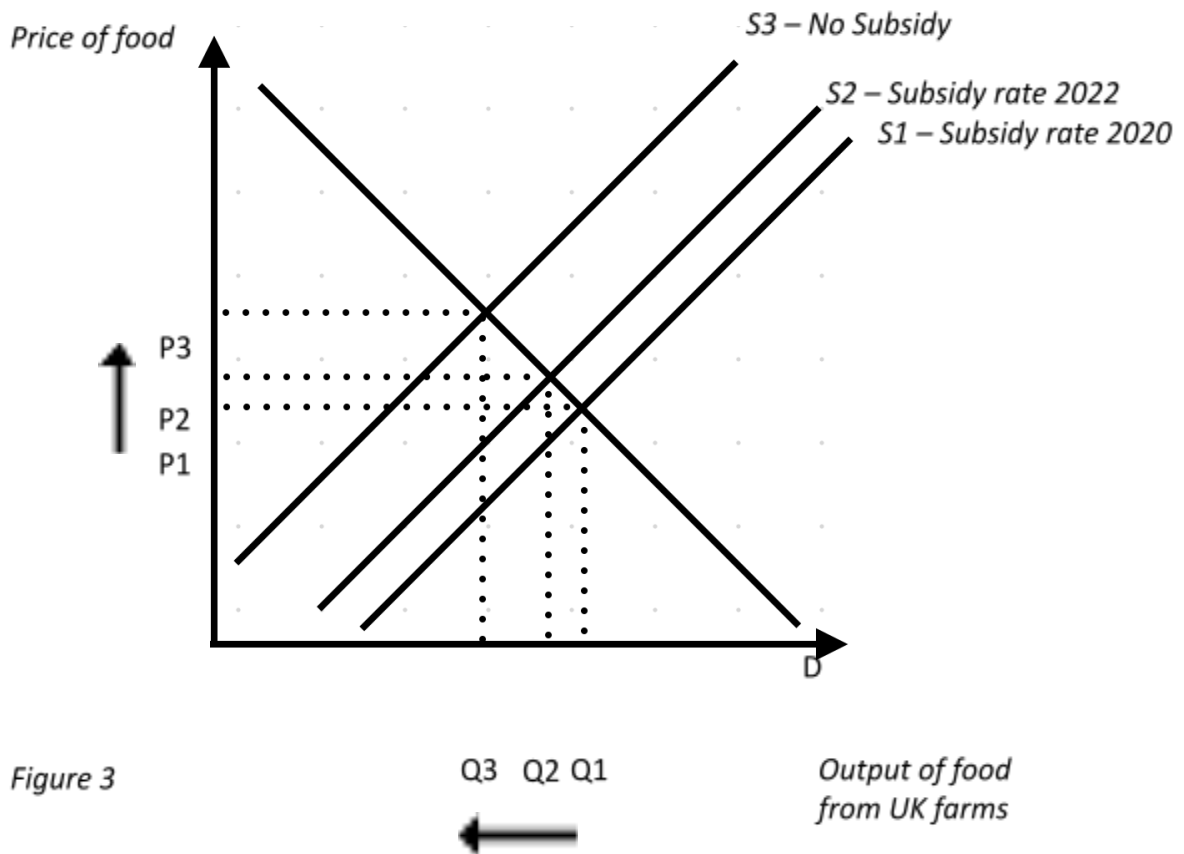
A decrease in subsidy contributes to increasing costs of production at all points, such as equipment running costs. Thus, farmers will spend less. This reduces farmers' supply, shifting it from S1. This will force the market to react. As quantity of food decreases, Q1 to Q3, prices of food will increase, P1 to P3. Any small farm who wants to remain at their previous output level would put pressure on their "wafer-thin margins" and thus go out of business[29].

However, Q1 is the expected output of the domestic agricultural sector. As this has fallen, imports were employed to supplement this shortfall. Currently 46% of the UK's total food is imported[30]. If continued, this will increase the UK's reliance on food imports, which in a 'rapidly changing landscape' could be devastating for the UK public.

In the past 5 years, food imports for the UK have drastically increased. Due to the UK leaving the EU, from 2019-2021 food import prices have increased by 3% a year resulting in the cost of food imports to rise by 5.8bn [31]. Furthermore, due to the increased disruption to supply chains following the pandemic and the war in Ukraine import prices for food material rose by 25.7% from January 2022 to 2023.[32]

These increases in the necessary food imports have been passed onto the consumer, resulting in higher food prices. At the end of 2022, food inflation was 17% compared to an overall inflation of 11%.[33]<2>

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A parliamentary report in October 2021[34] found that 'communication delays have not enabled farmers to adequately prepare for the transition between subsidy schemes. The rapid decline in subsidies can make the market less attractive for those interested in joining. This will make farming unsustainable for many. Eventually this will reduce the number of overall producers, permanently harming the amount of food produced and affecting food prices for consumers.

Enterprise and Capital

A firm which reduces its costs curve is described as dynamically efficient. Dynamic efficiency is a firm's productive efficiency over a time period at mass scale.
In order to reduce their costs curve, a farm will implement more efficient production processes. If farmers invest in improved capital, in the long run, the cost to produce the same quantity of good at scale will decrease- improving productive efficiency. To do this, farms will have to weather high short-term costs: the investment into new and more efficient farming equipment like tractors and combines. To proceed with investment, farms will have to take on risk and borrow money.

However, since 2021 bank lending to the agricultural sector has decreased year on year[35]. For many years, uncertainty surrounding future input costs and environmental schemes as well as difficulty in recruiting despite wage increases has resulted in farmers being more stringent in their investments. Additionally, rising interest rates discouraged farms from borrowing more[36].

Increasing uncertainty harms farmers' outlook on their businesses. This forces farmers to reduce their investment. This is evident as farmers have been advised to cut down on costs due to the reduction of the Basic Payment Scheme[37] and demand for new equipment has been decreasing[38].

Uncertainty in farming leads to farmers taking less risks; less investment into their business would mean less short-term costs but a loss of long-term cost savings.
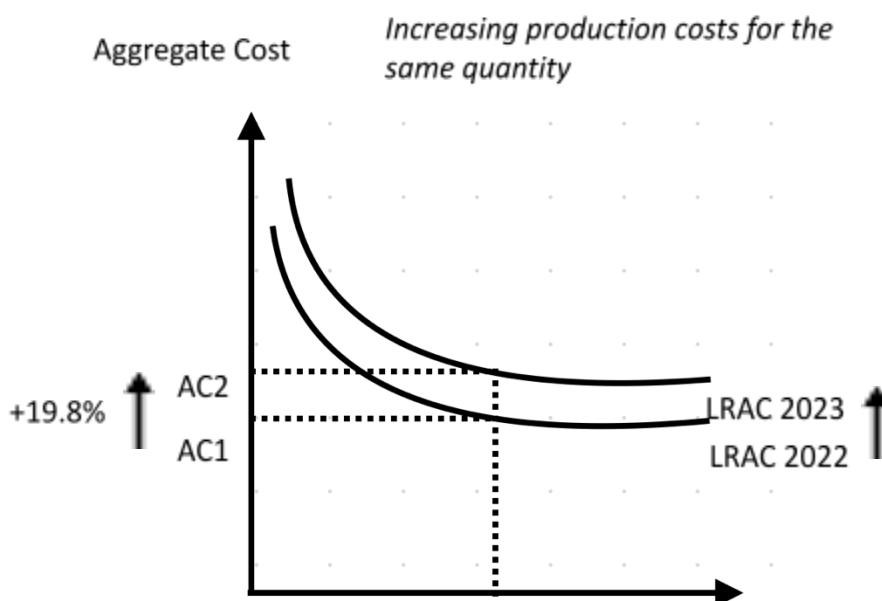
Even before the war in Ukraine, input costs for farms have been increasing. For example, energy input costs for farms have increased 34% between January and April 2022[39]. These stemmed from the 'unprecedented' food supply chains and production bottlenecks due to the Covid-19 pandemic, the OECD claims[40]. Increasing input costs harm farms as they lead to production costs at all points increasing. From 2022 to 2023, the cost to produce the same quantity increased on average by 19.8%[41], shifting the long run aggregate cost. Consequently, producing at the same quantity, Q, has increased in aggregate cost (total cost) from AC1, to AC2 for farms after one year.

Land- natural resources

Sanctions are a blockage on free trade. One of the primary sanctions imposed by the UK and its allies were the blocking of trading of goods which were described as important to the Russian economy. At the forefront of this was all Russian fuel; the most devastating impact to farmers was the sanctions placed on Russian Natural gas.
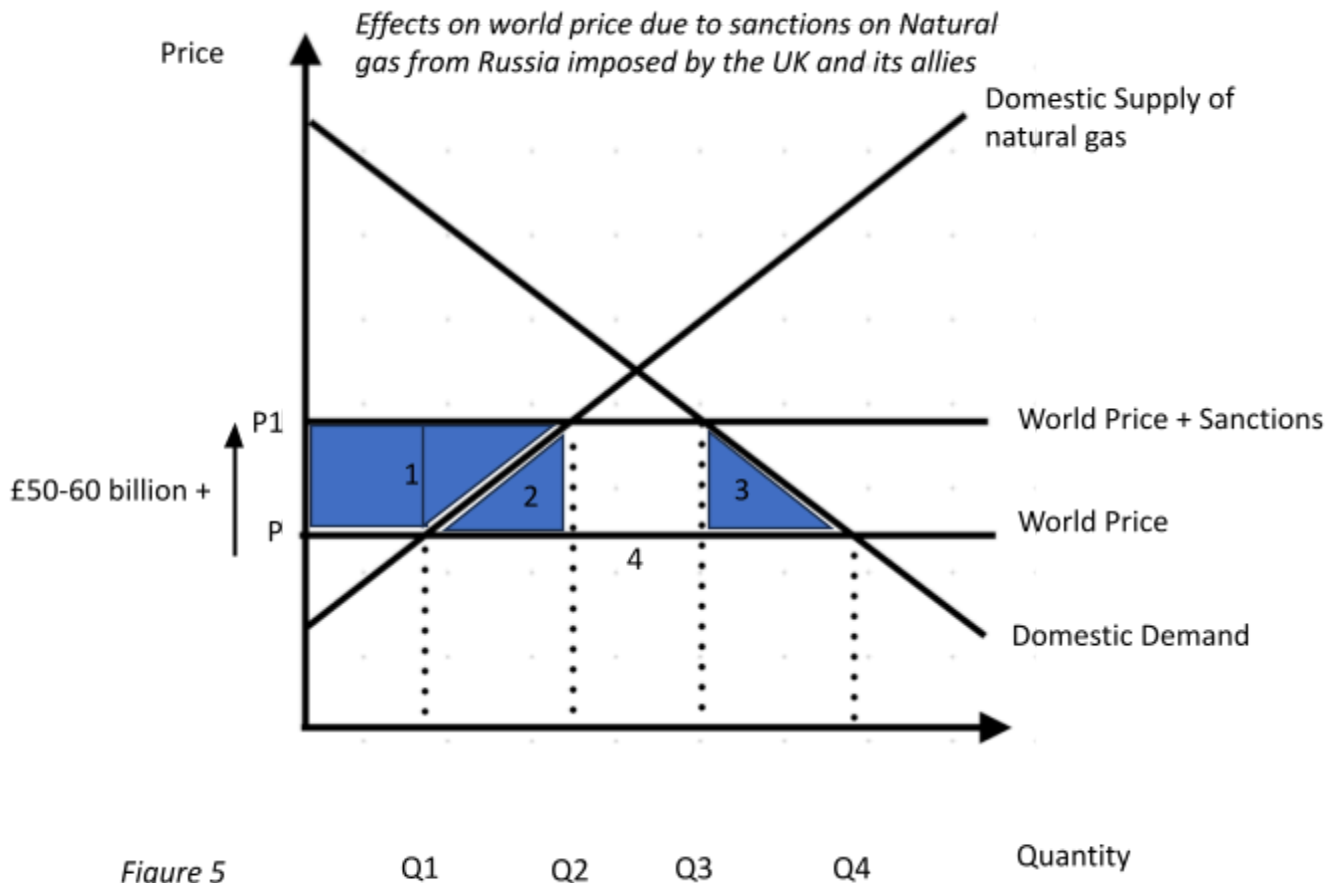
Figure 5

Without any sanctions, the price of Russian natural gas is at world price, P. The domestic supply is only at Q1 through reserves and natural gas production[43], while domestic demand is at Q4. The shortfall of supply, Q4-Q1, is met by imports. Russia is one of the main distributors of fuel to the world and the largest exporter of natural gas[44].

When sanctions were imposed, the world price rose to P1. Domestic demand contracts to Q3, whilst domestic supply expands to Q2. Post sanctions imports are Q3-Q2.
When countries stop importing from Russia, it puts pressure on other exporters. This extra pressure on other importers supplies and the sudden increased demand results in an increased price from the other exporters in the market, increasing the world price. The UK as a net importer is especially exposed to unpredictable price changes[45]. The rise in price from P to P1 is demonstrated by the UK spending an estimated £50-60 billion more on wholesale gas due to increased price on imports [46]. While producers increased their producer surplus with some domestic producers, such as British Gas and Shell, seeing profits triple[47] shown by Area1, consumer surplus has been reduced by Area1,2,3,4. Areas 2,4 represent the deadweight welfare loss, the cost to society.

The import bans on all Russian fuels resulted in an overall increase in price of all fuels, especially those used in transportation. Due to the decrease in supply in the UK, fuel prices have increased by as much as 40%[48].Increasing the price of transportation of food and operating machinery costs for farms and supermarkets which increases food prices on shelves. The increase in food prices on shelves can be represented as the deadweight welfare loss, Area1,2.

For the specific case of natural gas, these sanctions are particularly harmful to farmers. Natural gas directly impacts their agricultural output as it is needed in production of agricultural fertilisers[49]. Fertilisers are necessary in increasing the yield of farms by supplying an appropriate balance of nutrients to the soil; without it, nature does not efficiently replenish the nutrients in the soil to the rate needed for farming in the UK[50]. The director general of fertiliser Europe, Jacob Hansen[51], commented how natural gas represents "90% of the variable costs in fertiliser production". With an 80% increase in natural gas prices[52] demonstrated by P to P1 and an expected further increase in the future, farmers are facing an unprecedented impact directly due to the war in Ukraine.
This showcases the especially devastating effect an increase in natural gas prices can have on farms and thus consumers. The increase in food prices on shelves due to the sanctions can be represented as the deadweight welfare loss. It was estimated that as a direct result of the war in Ukraine, food prices in the UK have increased by 10.6%[53].

Timeline Analysis:
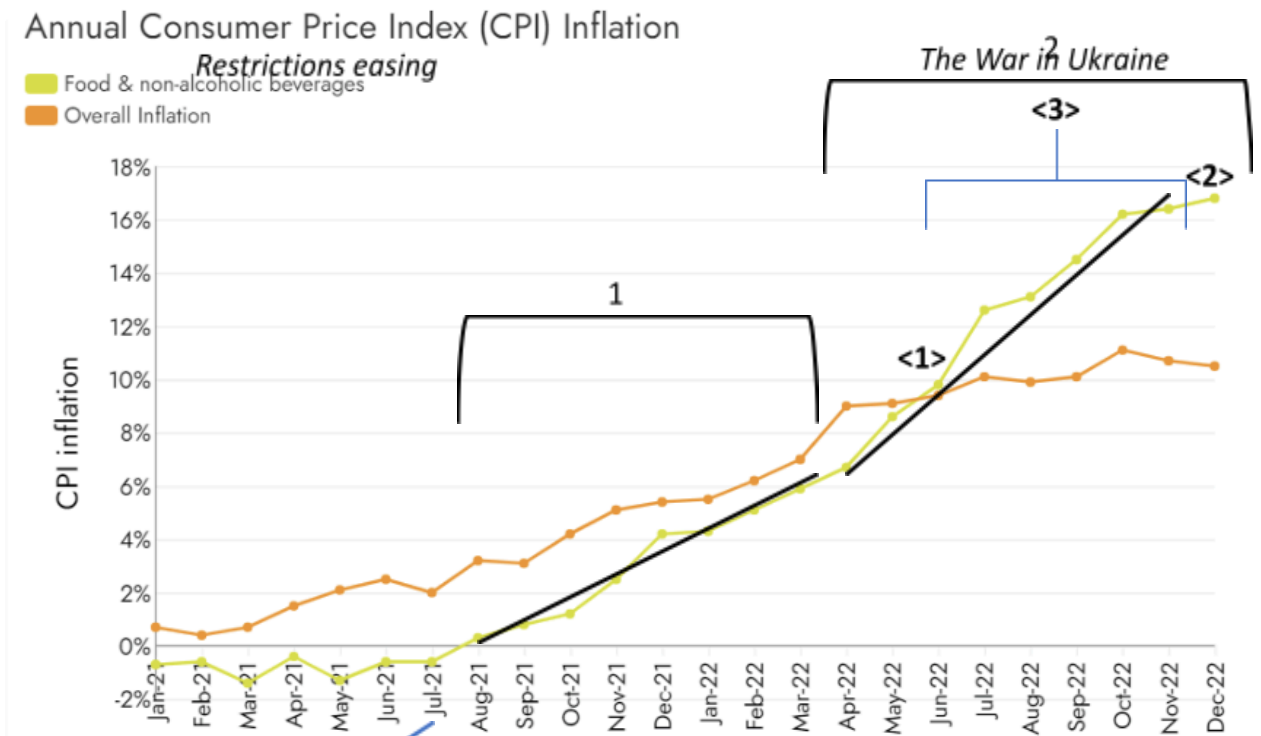
Figure 6, Data supplied by ONS; diagram from the Food Foundation[54]

      Discussing the extent of different impacts can be subjective. However, contextualising impacts against the rate of increase of food inflation can give a clearer picture. Combined with my primary research, it can convey a more established role of the extent of impacts on farmers. Analysing the base trends divides the food inflation into two distinct movements. August 2021 to March 22 and April 2022 to the end of 2022. The first trend can be simplified to occurring due to pressures to supply chains and factors of production[55], for farms from the pandemic and the UK leaving the EU[56], finally catching up to food price inflation after restriction easings from July 2021. This trend was forecasted to maintain its growth[57].

      The second trend showcases the pressures after the war in Ukraine beginning to affect supply chains and factors of production as well as the effects of sanctions such as increases in Natural gas prices. This affected the food prices to such an extent that it made the trend even steeper. However, this steeper trend is not entirely directly attributed to the war in Ukraine. Pressures on labour due to the war in Ukraine, the pandemic and the UK leaving the EU is shown at <1>. A decrease in subsidies leading to an increased reliance on food imports. Food imports' prices were already increasing due to the war in Ukraine, the pandemic and the UK leaving the EU, especially affected food prices, shown at <2>. The lack of investment from farmers due to uncertainty over the past 5 years, resulted in farmers being severely impacted when the costs of food production increased, contributing to sustained high food prices shown at

<3>. Furthermore, The Food, Farming and Countryside commission commented that due to uncontrollable factors such as climate change-extreme weather events becoming more common- as well as rising costs of production due to the war in Ukraine have put more pressure than previously seen on farmer's ability to produce food, leading to even further accelerating increased prices of food.

Conclusion

Farmers in the UK have faced unprecedented pressures. It is clear to see that an emulsion of factors was responsible for a record level growth rate of food inflation.

At first, it may seem like the pressures due to the war in Ukraine primarily caused a trend in food inflation rate not seen in 40 years.

However, these pressures had existed before the war in Ukraine. Most notably resulting due to the UK leaving the EU and the pandemic. The war in Ukraine significantly exacerbated the impacts that farmers were already facing in their factors of production, from food imports prices increasing due to a decrease in farmers' subsidies, pressures on production due to labour shortages and uncertainty surrounding farming leading to less investment and less productive efficiency. Furthermore, new pressures were created such as sanctions on Russian fuel which led to huge increases in fertiliser production costs. Overall, this resulted in an even steeper trend of the food price inflation.

The war in Ukraine can be considered a pivotal point for farming in the UK. It worsened the pressures already experienced by farms and created new pressures, resulting in record level food inflation rates. If no help is given to farms, the future prospects of farming in the UK appear uncertain.

Evaluation:

Farms are in dire need of policies to help improve their situation. The government needs to improve their policies to support farms and mitigate the pressures they have faced.

To perhaps work towards helping farmers, I could have distributed a questionnaire that asked farms which parts of their business struggle the most financially and seek their input on potential ways to support them that would be the most beneficial and economically viable.

For this research, estimations had to be made. There is always a time lag between events and the affects seen. Predicting the time lag can prove difficult, this can result in some food price increases being attributed to different impacts.

Furthermore, impacts cannot be mathematically calculated; they always have to remain subjective. Perhaps providing a questionnaire to farmers to rank their viewpoint of impacts on their business can numerically show the perceived impact of different pressures on farms.

Works Cited

FoodNavigator. Oliver Morrison. Ukraine flag surrounded by crops.February 2022) [Accessed
July 2023]

https://www.foodnavigator.com/Article/2022/02/25/Why-the-Ukraine-conflict-could-spark-dang
erous-times-for-food-prices-and-food-security

BBC News. Russian invasion of Ukraine could cause global food crisis, UN warns. (May 2022)
[Accessed July 2023]

https://www.youtube.com/watch?v=3sojbLRXNmw

WSJ. War in Ukraine Cuts Fertilizer Supply, Hurting Food Prices and Farmers (April 2022)
[Accessed July 2023]

https://www.youtube.com/watch?v=8KI4A9UECSA&pp=ygUaVWtyYWluZSB3YXIgaW1wY
WN0IFVLIGZvb2Q%3D

House of commons. The effect of the war in Ukraine on UK farming and food production (July
2022) [Accessed July 2023]

https://researchbriefings.files.parliament.uk/documents/CDP-2022-0147/CDP-2022-0147.pdf

ONS. Imports and exports data (November 2022) [Accessed July 2023]

https://www.ons.gov.uk/economy/nationalaccounts/balanceofpayments/articles/theimpactofsancti
onsonuktradewithrussia/november2022

Gov.UK. Ban on Russian Fuel (Updated April 2023) [Accessed July 2023]

https://www.gov.uk/government/publications/uk-ban-on-russian-oil-and-oil-products/uk-ban-on-r
ussian-oil-and-oil-products#:~:text=The%20ban%20came%20into%20effect,Russian%20
oil%20to%20third%20countries.

RadioLiberty. Reid Standish. China and Russian Fuel (June 2022) [Accessed July 2023]

https://www.rferl.org/a/china-russia-ukraine-war-sanctions-analysis/31915619.html

Wikipedia. Russia is the largest exporter of Natural gas (Updated December 2022) [Accessed
July 2023]

https://en.wikipedia.org/wiki/Petroleum_industry_in_Russia

Reuters. Muyu Xu and Chen Aizhu. China's Record amounts of Russian fuel. (March 2023)
[Accessed July 2023]

https://www.reuters.com/business/energy/chinas-march-imports-russian-oil-may-hit-record-shipt
racking-data-2023-03-02/

Yara. Main ingredient of agricultural fertilisers is natural gas [Accessed July 2023]

https://www.yara.com/crop-nutrition/crop-and-agronomy-knowledge/how-we-make-our-fertilize
r/#:~:text=In%20a%20modern%20plant%2C%20nitrogen,air%20to%20form%20nitroge
n%20fertilizer.

Yara. Quote International agriculture [Accessed July 2023]

https://www.yara.com/knowledge-grows/why-do-plants-need-fertilizers/#:~:text=Without%20fer
tilizers%2C%20nature%20struggles%20to,yields%20will%20deteriorate%20over%20ti
me.

Business Insider. Ryan Hogg. 80% increase in natural gas (August 2022) [Accessed July 2023]

https://www.businessinsider.com/uk-farms-faces-17-million-amid-soaring-natural-gas-prices-2022-8?r=US&IR=T

EuroNews. Jorge Liboreiro. Jacob Hansen quote (April 2022) [Accessed July 2023]

https://www.euronews.com/my-europe/2022/05/23/explained-why-higher-gas-costs-lead-to-higher-food-prices

Gov.uk. 34% energy input costs farms (Updated December 2022) [Accessed July 2023]

https://www.gov.uk/government/statistics/agricultural-price-indices

OECD. quote (June 2020) [Accessed July 2023]

https://www.oecd.org/coronavirus/policy-responses/food-supply-chains-and-covid-19-impacts-and-policy-lessons-71b57aea/

House of Commons. Ukrainian seasonal workers (July 2022) [Accessed July 2023]

https://researchbriefings.files.parliament.uk/documents/CDP-2022-0147/CDP-2022-0147.pdf

Forbes. Frey Lindsay. Labourers figures (May 2020) [Accessed July 2023]

https://www.forbes.com/sites/freylindsay/2020/03/24/with-no-eu-workers-coming-the-uk-agriculture-sector-is-in-trouble/?sh=13bf88c0363c

Parliament Committee. Farmers mental health [Accessed July 2023]

https://committees.parliament.uk/writtenevidence/43055/pdf/

BBC. Average age of farmers is 59 (Updated December 2022) [Accessed July 2023]

https://www.bbc.com/future/bespoke/follow-the-food/the-ageing-crisis-threatening-farming/

Farmers Weekly. Johnathan Riley. Farmers wages increase (December 2022) [Accessed July 2023]

https://www.fwi.co.uk/business/business-management/finance/farm-wage-rate-rises-at-5-plus-amid-recruitment-challenge#:~:text=Farmers%20and%20landowners%20face%20workforce,in%20recruiting%20and%20retaining%20staff.

Farmers Weekly. Debbie James. Farmers wage increase effect (December 2022) [Accessed July 2023]

https://www.fwi.co.uk/business/business-management/staff/farming-estates-average-5-4-pay-rise-in-2022-but-struggle-to-recruit

Courthouse News Service. Dominic Glover. Basic Payment Scheme (January 2023) [Accessed July 2023]

https://www.courthousenews.com/subsidies-boosted-in-bid-to-win-over-skeptical-uk-farmers/#:~:text=British%20farmers%20are%20currently%20reliant,an%20increasingly%20perilous%20financial%20position.

Public money for public goods(January 2023) [Accessed July 2023]

https://www.fwi.co.uk/business/business-management/agricultural-transition/ofc-2023-farmers-told-to-back-public-money-for-public-goods

Courthouse News Service. Dominic Glover. A parliamentary report in October 2021 found that 'communication delays have not enabled farmers to adequately prepare for the transition.' (January 2023) [Accessed July 2023]

https://www.courthousenews.com/subsidies-boosted-in-bid-to-win-over-skeptical-uk-farmers/#:~:text=British%20farmers%20are%20currently%20reliant,an%20increasingly%20perilous%20financial%20position.

Guardian. Richard Partington. Food prices have risen 19% (April 2023) [Accessed July 2023]

https://www.theguardian.com/business/2023/apr/19/why-are-uk-food-prices-up-by-19-and-which-foods-are-worst-affected

Local Government Association. The UK food poverty rate is now among the highest in Europe. (March 2023) [July 2023]

https://www.local.gov.uk/parliament/briefings-and-responses/debate-tackling-poverty-and-cost-food-house-commons#:~:text=The%20UK%27s%20food%20poverty%20rate,food%20poverty%20in%20January%202022.

ONS. The production costs have increased on average of 19.8% (March 2023) [Accessed July 2023]

https://www.ons.gov.uk/economy/inflationandpriceindices/articles/recenttrendsinukfoodanddrinkproducerandconsumerprices/january2023

UK parliament. Frank Eardley. To help farmers manage costs and give them more time to adapt.' (June 2022) [Accessed July 2023]

https://lordslibrary.parliament.uk/rising-cost-of-agricultural-fertiliser-and-feed-causes-impacts-and-government-policy/

Breaking Barriers and Building Bonds: An Ethnographic Exploration of Women and Community in a Scientific Sanctuary By Ruth Shikanov

Abstract

This ethnographic study delves into the dynamics of a reproductive research lab, led by Dr. Ariella Shikanov. The lab focuses on preserving and restoring reproductive and endocrine function for at-risk populations, with a specific focus on engineering supportive environments for ovarian follicles. Focused on women's roles in scientific research, the research sheds light on the transformative impact of fostering close friendships and sharing common backgrounds within a professional setting. In a competitive and male-dominated environment, the significance of solidarity cannot be overstated.

The bonds forged in the lab contribute significantly to the well-being of its members, emphasizing the importance of human connection as a driving force for success. Moreover, the research advocates for the recognition and appreciation of minorities in STEM, challenging prevailing stereotypes and highlighting the enriching effect of shared identities on creativity and collaboration.

In a broader context, this study reinforces the urgent need to dismantle historical biases that have marginalized minorities in science, particularly the persistent underrepresentation of women in reproductive research. Beyond moral imperatives, the findings emphasize that supporting diversity and promoting inclusivity are essential components for advancing scientific discovery.

The empowering environment cultivated in the reproductive female research lab serves as a beacon, pointing towards a future where every individual, regardless of gender or background, can contribute to and benefit from the scientific community. This research contributes to the ongoing dialogue about fostering inclusive environments in science and underscores the critical role that unity plays in creating a supportive and uplifting atmosphere.

Introduction

I'm wearing a sweatshirt, jeans, and warm socks, yet I still feel the hair on my arms stand up. Spotless black countertops are adorned with pipettes, beakers, bins for organization, and microscopes. Hewlett-Packard computers are at each desk, displaying a multitude of tabs. The sounds echoing throughout the lab are the constant hum of centrifuges and refrigerators, emphasizing the continuous activity in the lab; the satisfying clicking of keys as graduate students enter numbers, write emails, and analyze data; and the soft patter of footsteps following those in white lab coats who wear protective, chunky, clear lab goggles. And all of them are non-male.

According to CareerExplorer, in 2023, the male-to-female ratio was 54% to 46% employed in biomedical engineering, whereas in other fields, such as mechanical engineering, ratios were 84% men and 16% women and in chemical engineering was 74% men and 26% women. Without a doubt, engineering is a male-dominated field, but the biomedical engineering

ratio is not as stark as the rest. The fields of science and math hold a historical gender bias against women — this is especially prevalent in the recognition of achievements in the scientific world, such as getting invitations to speak at conferences, the receival of awards, citations, recognition of achievements, and during the paper-publishing process.

The mission of the Shikanov lab is to preserve and restore reproductive and endocrine function for at-risk populations, such as women who suffer from premature ovarian insufficiency (POI), with a specific focus on engineering supportive environments for ovarian follicles. From a historical standpoint, women's health has not been at the forefront of research funding. In fact, the over-citation of male researchers is primarily driven by other male researchers (*nature physics*). Scientific research is competitive, with scientists competing for limited funding and high-impact journals, and on top of it, to be the minority amidst this challenging process, it is undoubtedly stressful. Stressors in the Shikanov lab can appear as gels failing to form or not meeting critical deadlines for papers, and these stressors can pose major challenges. I wanted to further understand how the lab supports one another when doing research that is dedicated to women's health because, as stated above, there is a long history of those who are non-male struggling with underrepresentation and discrimination. My central research question is, "How do the people, who are predominantly women conducting women-focused research, in this lab create a sense of community within a male-dominated scientific world?" Together, the lab fosters a supportive, uplifting environment through a multitude of ways by establishing close friendships and sharing similar backgrounds, identities, and stories.

Why this research?

My mother — Ariella Shikanov — has always been my role model. She is the most dynamic, headstrong woman I know. Beyond my mother, I am surrounded by other non-male figures who have led (and lead) lives in STEM — my paternal grandmother was a chemist, my maternal grandmother was a mathematics teacher, and my sibling, Eve, completed their undergraduate in biomedical engineering at the University of Michigan (UofM) and is currently in the Industrial Operations Engineering graduate program at UofM. I only started to develop an interest in science in high school, specifically biology and chemistry. But that is not to say that I didn't struggle; it was not an uncommon sight for my sister or mother to help me with organic chemistry or physics problems as I grappled with complex concepts. And it wasn't unusual to hear "horror stories" from the both of them as they unpacked uncomfortable, yet very real experiences that they underwent in the field. Eve has told me about the student dynamics in their engineering classes, sharing that the more feminine girls are objectified and dismissed, despite them often setting the academic curve. Eve occasionally overheard their male peers badmouthing female classmates as they made comments on their appearances and capabilities.

"Being in a class of mostly men and not being regarded as a person, let alone a person of value, it just made me want to work harder to spite them," Eve said. "I am first perceived as a woman, which already puts me low on the ladder, and then later to be recontextualized as a gender-queer person, it only pushed me to be smarter, be funnier, and to outpace them in every way."

I always knew that women were underrepresented in STEM and minorities even more so, but I failed to understand the deeper and more critical intricacies that helped determine success within the scientific sphere, such as receiving credit for one's work or getting crucial funding for research.

My mom is the principal investigator of the lab. Given my mother's position of authority, my presence may have impacted how people will interact with one another, the lab and its equipment, and what they say in an interview, yet these worries did not manifest. The techniques I employed were interviews and observations; I could not engage in participant observation, one of the most traditional practices of ethnographic research since I do not hold the skills to do work with the scientific equipment in the lab. However I was met with kindness and honesty during my interviews, and I conducted my observations as if I were invisible, blending in as I took notes on my computer and my typing joined the symphony of the others. With regards to terminology, "women" and "woman" are terms that encompass female-bodied people who may or may not identify as women.

Ariella and her parents immigrated to Israel when she was 13 years old, and she always wanted to be a doctor, just like her father. But her parents urged her to go a different direction, claiming that "it was not a good choice for [her] and it is not a good profession for women." In the past decade, the demographic characteristics of physicians in Israel show that female physicians range from 42% to 45%, meaning that this area is male-dominated. (Haklai, Z., Applbaum, Y., Tal, O. et al.)

 As an associate professor and scientific researcher, The path to becoming a doctor in Israel is not an easy feat. Admission into medical schools is extremely competitive, made especially more difficult as there are only five institutions in the entire country and applicants must obtain high scores, in addition to excellent high school grades and a *bagrut* equivalent, a matriculation certificate. After realizing that being a doctor was out of the question, Ariella applied to pharmacy school, but pharmacy school would still be challenging. Until the beginning of this millennium, there was only *one* school dedicated to pharmacy: The Hebrew University in Jerusalem. At the university, the main focus was on the product, rather than the people, and Ariella wanted to make a difference, an impact.

"My mom had this vision that I will be wearing a white lab coat and I will be working in cosmetic pharma," Ariella said. "I will be making perfume and I will be smelling stuff all day, but I didn't want to do that."

Ariella went to pharmacy school for four years and after graduating, she began her internship in CVS, packing prescriptions as long lines extended out the door. Every day she came for her shifts, Ariella was full of excitement, always "fast, professional, very kind to the people, and catching mistakes." But she had achieved all there was to accomplish — packing prescriptions at CVS was not her ultimate goal. That left the question of, "What's next?" Promptly after, Ariella met who would be her husband, who was going to Jerusalem to start his residency. Ariella's mom pushed her to do a PhD, yet she had no idea what that would entail — "'What's a PhD?', no one in my family had ever done a PhD." But blindly, she followed through,

developing targeted treatments for solid tumors with little passion for what she was doing. In 2007, she received her PhD in Medicinal Chemistry and Pharmaceutics and was ready for the next step. She joined a bioengineering lab that focused on biomaterials, gene delivery, and cell-based treatments at Northwestern University and continued doing her research, but with a specific lens on tissue engineering and regenerative medicine with a focus on reproductive biology. It is then that she found her passion, shortly pursuing her faculty position at UofM, studying reproductive tissue engineering. Women's health was immensely under-studied and continues to be under-studied. An analysis of data from the United States National Institutes of Health (NIH), which spent $45 billion on biomedical research in 2022, showed that many diseases that impact more women compared to men are underfunded, and more than 20,000 clinical trials in the United States between 2000 and 2020 showed that women were under-represented in some trial types and over-represented in others (*Smith, pp. 28-29*). For example, 42.9% of participants in oncology clinical trials were women between 2000 and 2020, but experienced 46.5% of the burden (*Smith, pp. 28-29*). Similarly, women were underrepresented in neurology and immunology. When Ariella joined UofM, the number of research laboratories that were doing research at the interface between engineering and reproductive science in the US could be counted on one hand. Ariella was able to grow her research program, attract talented and hard-working students, obtain funding, and remain committed to her vision of creating fertility preservation options for as many women as possible. Because of the rich and diverse research community at UofM, Ariella expanded her research into understanding the effects of gender-affirming hormone therapy on reproductive outcomes in collaboration with the Department of Obstetrics and Gynecology.

A stark majority of clinical studies were done on men and male animal models, which caused a severe lack of knowledge regarding female biology and physiology. To combat assumptions that are rooted in the false ideas that female mice are more variable than males, research has shown that there is no sex difference found in overall variability (*Prendergast BJ, Onishi KG, Zucker I*). In fact, males exhibited a higher variability in nervous system measures, like neurochemistry and electrophysiology measures (*Becker JB, Prendergast BJ, Liang JW*).

"But when people work with cells, they don't even care if the cells are coming from the female or male donor, which is a huge problem," Ariella said. "There are key differences that exist, in terms of receptors and how cells respond to different factors."

As a woman, Ariella's work crossed many paths in her life. As a mother, her experiences of having children versus those who have trouble conceiving, or young children diagnosed with cancer, was something she became deeply passionate about. It was extremely disheartening in her eyes that prepubescent females can lose their fertility and their ability to undergo physiological puberty, due to cancer: "It was very close to my heart, me having two daughters, thinking, what would I do if they were sick?"

Conversations and Body Language: Purely Scientific?

During the project, my field site was the lab. My research regimen occurred two to three times a week and occurred in the midafternoon to late evening. With a keycard in hand, I pulled

the heavy door open. I was met with the sound of centrifuges shaking and the satisfying clicking against keyboards filled the corner of the lab. Greeted with quiet smiles, I set up my computer at an empty counter. In the corner, images of ovaries and follicles, signaling pathways regarding steroid production, and presentation posters fill the wall. Typically, these posters don't have a use after being presented, but Ariella keeps them as a tool for knowledge and a symbol for pride, so students can look at previous work done in the lab and be inspired. Conversation filled the atmosphere; chatter ranged from quiet whispers to voices being the only ones in the entire space.

While conservations stem from lab tasks, imaging, and writing emails, they tended to drift and form into casual conversations. Monica Wall, a graduate student, and Kimmi Chan-Sui, the research technician, were in the lab together and both of them were on their computers. Simple compliments were exchanged between each other, and Kimmi said she liked Monica's earrings. While others may move on, they had a conversation regarding destinations, like Boston, and talked about the idea of the lab going out to art fairs, Halloween festivals, and drag shows together. Talking amidst people is not limited to their research and their interactions hold no tension, awkwardness, or competition, but rather a sense of community.

The lab has masters, undergraduate, and PhD students all frequently sharing the same space. There was an interaction between two older graduate students — Margaret and Jordan — and two younger graduate students — Delaney and Taylor — to discuss a 'special task', inventory. In the lab, there are a multitude of duties to be done, one of which is inventory. While it may be tedious, it is crucial; it is done to ensure that there is no understocking or overstocking of materials, equipment, and other resources. Margaret and Jordan had done it for the past few years and it was time to pass it on, so they called Delaney and Taylor over. As they spoke, it wasn't 'formal' — In the lab, terms like 'girl' and using '#' in sentences are common, and while this language may seem unexpected, I believe that it is a sign of comfort and affirmation.

It was a Friday night, and pitch-black outside, yet the lab was still active. Delaney and Taylor were sitting at their respective desks, clicking away. Eventually, Delaney started to pack up, but Taylor was still working. "Don't stay too late," Delaney said while putting on her coat. She said this a few times while engaged in conversation about their weekend plans and wished they both took the time to relax. This further supports the idea that the lab students truly care for each other, and the work they do is not the only factor that builds their friendships.

This pattern of comfort also translated to the lab; it was common for those to lift their leg and tuck them in as they sat at their desks, conversing with others or doing their own work. Daisy Kurien wrote that body language 'speaks' more than verbal communication. Composing various postures, gestures, eye contact, and facial expressions, information is received and conveyed much more effectively, thereby enhancing the communication between people (*Abdulghafor, R., Turaev, S., & Ali, M. A. H.*). Aside from the informal tone, the conversations occurring in the lab consist of their futures in academia and resumés and CVs. But these conversations do not serve as a competition ground, but rather to give support and congratulations. It is rare for a woman's article to be at the top of search bars and journals and even rare for her name to be listed as one of the first authors (*nature physics*). Going

hand-in-hand with the idea that there is a feeling of community, Jordan and Margaret were having a conversation about failing to be properly recognized in a paper. Jordan insisted that Margaret's name should be on a certain paper, as she helped create the outline, but also because she is finishing graduate school and deserves the recognition. These people care deeply for one another as both coworkers and friends.

Voices from the Lab

Jordan, who has always been intrigued by biology and is an IVF baby along with her siblings, began exploring tissue engineering, regenerative medicine, and reproductive biology. Her passion for reproductive issues stems from the underrepresentation of women's health in research. Jordan highlights the imbalance in experimental studies, where male animals are predominantly used, overlooking the unique aspects of female biology.

Jordan recognizes the challenges, particularly the male-dominated research, and how it affects the publication, funding, and recognition of women-focused studies. Acknowledging that many researchers in women's health face hurdles due to gender biases, including herself, Jordan also appreciates the unity and community that the lab promotes via the conversations that touch on topics related to womanhood such as menstrual cycles, reproductive health, pregnancy, and childbirth.

"The one thing we talk about a lot is our periods and menstrual cycles, and how everybody's different or has a normal cycle," Jordan said. "We talk a lot about the issues that we've had, whether or not we need some Advil at that current moment, pregnancy and what giving birth is like, experiences with being pregnant, obviously, mostly from Andrea [a recently graduated Ph.D. student.]"

Adding onto the challenges like the inherent difficulties in gaining recognition and funding, the prevalence of societal taboos around discussions of reproductive health and sexual education is unavoidable — there have been instances of women approaching Jordan privately to discuss women-related issues and topics, such as irregular periods and having their eggs frozen.

"[These women], they don't feel comfortable talking about it because it *is* taboo," Jordan said. "To have that one sense of the somebody who may know something, they grab at it. You can tell they're eager to talk about it, but they aren't able to." Despite these challenges, Jordan expressed optimism about the changing landscape, fueled by evolving societal attitudes and a younger generation's willingness to challenge traditional norms.

Excited to help undergraduates and their experience in the lab, Delaney is also passionate and optimistic about the future and shares a similar perspective and background as Jordan. Interested in science courses like biology and chemistry in high school, she wanted to be a scientist but disliked how scientific research was removed from patients. Once introduced to the diverse realm of biomedical engineering, Delaney knew what she wanted to do with her career. To her, the lab's caring nature assists her through the ups and downs during these years of her life. The lab being predominantly women also provides a unique sense of comfort for Delaney.

"I think our lab is very close and we have one of the best lab environments that I have ever been a part of," Delaney said. "I think the energy would be a lot different if there was a man in the lab. We have many conversations about women's health in the lab that I think a man could not fully relate to."

Additionally, research is typically formatted in the form of papers, which are difficult to read and are information dense. The need for more accessible ways to communicate scientific findings to the public is crucial in order to bridge the gap; social media platforms can cater to both scientists and public audiences as an accessible medium. "For any science paper, I would argue it is hard to read for any person," Jordan said. "It's written in a language that you have to learn how to write, as much as you will have to learn how to read it."

The Citation Conundrum

While my fieldwork took place in the lab, I also spent time in my mom's office. Enclosed by four beige walls adorned with awards and academic posters, my eyes closely analyzed each and every corner of her office. The shelves are full of organic chemistry, tissue regeneration, and biology textbooks, rich with academic text and complex diagrams. Parallel to these crowded shelves is my mom's desk. Her computer stands tall with triumph, while dozens of papers, grants, and to-do lists are scattered across the tabletop. Perpendicular to her desk is her cabinet and that, too, is also embellished with colorful sticky notes, littered with yet more tasks and reminders. And those aren't enough — her calendar is hectic and indecipherable, crammed with short and long boxes. We sat across from each other at a circular table with a whiteboard with magnets holding microscopy images of ovaries and follicles and schematics of the ovarian cycle hanging overhead.

We briefly discussed her most recently published paper which was about the single-cell RNA-sequencing of human oocytes before unpacking the issues and biases held against women during the citation and publishing process.

Ruth: What challenges come as a woman in STEM?
Ariella: Being a scientist is difficult to begin with because you have to face a lot of rejection. Regardless of your manner, regardless of what you do. Grants are very competitive, publications are very competitive and everything is based on peer review, which is not perfect, but that is the only system that works. You send the publication that you send your grant to and other scientists review it scientists are very critical, but the amount of money available is also very limited. You really have to be the best of the best. It's just being a general scientist. And if you add to this, working in a very narrow field that other people do, so whenever a grant is reviewed, people have to give you a score on the significance of your research. So convincing other people, *men*, that this kind of research is significant, is an extra barrier. I have to invest extra time, write very compelling arguments, and try to convince people that what we do is important. It's critical long-term for women's health in general. It's important for the short term for these girls who undergo sterilization treatments. It's just much more challenging.

Ruth: If I go to NIH, for example, and I look up papers, are the first things to pop up going to be male-written papers?

Ariella: The first *15* are going to be males.

Ruth: Because of the algorithm or because of what? What do you think causes that?

Ariella: Because there's just more of them, statistically. When you send out a paper to publish in *nature*, it has been shown that the women-authored papers are going to be reviewed more harshly. You cannot publish your work in top journals. So, you go to a lower journal, the fact that it's a lower impact factor journal means it is going to be read by fewer people. Here's your first filtration. And then, because you can publish only in lower-impact journals, your funding is going down because NIH and other funding agencies want to find the most promising research. If you don't have funding and you cannot publish in high-impact journals, students, like the best students, don't go to you. *Everything* is connected. I always tell my students that I'm grateful to them, because you know, they still choose to come to a woman-led lab, knowing that there's going to be more struggle to publish and they will struggle to get money, struggle to get recognition.

Change is Inevitable

The ethnographic exploration into the reproductive research lab uncovered a number of things: a profound narrative of support, unity, and empowerment among those in the lab, a deeper understanding of women and their role in scientific research, and the importance of women's health research. The lab serves as a testament to the transformative impact of fostering close friendships and sharing common backgrounds within a professional setting. In a competitive and male-dominated environment, the significance of solidarity cannot be overstated. This research sheds light on the critical role that unity plays in creating a supportive and uplifting atmosphere.

The bonds forged in the lab contribute to the well-being of its members; the importance of human connection is underscored as a driving force for success. Furthermore, my research advocates for the recognition and appreciation of minorities in STEM, emphasizing that they are not only deserving of credit but are equally qualified and capable contributors. The findings challenge prevailing stereotypes and demonstrate that shared identities and backgrounds enrich the work environment, fostering creativity and collaboration.

In the broader context, this research reinforces the call to dismantle historical biases that have marginalized minorities in science. The persistent underrepresentation of women is evident in the field of reproductive research, and it is not only unacceptable but also detrimental to scientific progress. As we move forward, it is imperative to recognize that supporting diversity and promoting inclusivity are not just moral imperatives but essential components for advancing scientific discovery. The empowering environment cultivated in the reproductive female research lab serves as a beacon, leading toward a future where every individual, regardless of gender or background, can contribute to and benefit from the scientific community.

Works Cited

Schwartzberg, E., Marom, E. Clinical pharmacy in Israel versus the US, can we "compare apples to apples"?—commentary. Isr J Health Policy Res 10, 72 (2021). https://doi.org/10.1186/s13584-021-00508-3

Smith, Kerri. "THE FUNDING GENDER GAP." *Nature*, vol. 617, 4 May 2023, pp. 28–29.

Becker JB, Prendergast BJ, Liang JW: Female rats are not more variable than male rats: a meta-analysis of neuroscience studies. *Biol Sex Differ* 2016.

Prendergast BJ, Onishi KG, Zucker I: Female mice liberated for inclusion in neuroscience and biomedical research. *Neurosci Biobehav Rev* 2014, 40:1–5.

Just citations. *Nat. Phys.* 18, 1131 (2022). https://doi.org/10.1038/s41567-022-01803-9

Abdulghafor, R., Turaev, S., & Ali, M. A. H. (2022). Body Language Analysis in Healthcare: An Overview. *Healthcare (Basel, Switzerland)*, *10*(7), 1251. https://doi.org/10.3390/healthcare10071251

Haklai, Z., Applbaum, Y., Tal, O. *et al.* Female physicians: trends and likely impacts on healthcare in Israel. *Isr J Health Policy Res* 2, 37 (2013). https://doi.org/10.1186/2045-4015-2-37

Macroeconomic Metrics and Political Choices: Navigating the Interplay of Global Economics and Geopolitical Tensions By Tom (Haoran) Liu

Abstract

Macroeconomic metrics play a crucial role in shaping policy decisions and political outcomes, but there are ongoing debates surrounding their measurement and interpretation. This literature review examines the complex interplay between macroeconomic indicators, political choices, and geopolitical dynamics, highlighting the importance of accurate and consistent measurement despite inherent challenges. The review synthesizes empirical evidence from researchers who emphasize how choices in macroeconomic measurement influence political decision-making and global economic stability. It also explores the emerging opportunities and challenges posed by technological advancements, such as big data analytics and artificial intelligence, and the integration of behavioral insights into macroeconomic analysis and policy. The review supports the need for a holistic, adaptive, and inclusive approach to economic analysis and policymaking that recognizes traditional indicators' limitations and political economy factors' importance while fostering interdisciplinary dialogue to navigate an increasingly connected, complex world.

Introduction

This literature review examines some of the existing body of knowledge on the relationship between macroeconomic metrics, their measurement variations, and the subsequent impact on political choices across diverse contexts. A key focus is to compare and contrast the methodological approaches, sample sizes, data sources, and other relevant aspects employed across the studies examined. By identifying commonalities and differences, insights are uncovered into the strengths, limitations, and potential biases inherent in various measurement techniques and data sources used to evaluate macroeconomic indicators such as economic growth, inflation, unemployment, and public deficits. The review synthesizes empirical evidence from scholars like Coyle (2014), Fioramonti (2017), and Karabell (2020), who highlight how choices in macroeconomic measurement influence political decision-making and shape global economic dynamics, particularly amid geopolitical tensions. Discussing the implications of commonalities and differences among studies contributes to a further understanding of the complex interplay between macroeconomic measurement, political choices, and consequences for the global economy while highlighting the importance of accurate, consistent metrics despite inherent challenges (Börzel & Risse, 2016).

By bringing together diverse perspectives and findings from various disciplines, including economics, political science, and public policy, this review seeks to disentangle the complex interplay between macroeconomic measurement, political decision-making, and their consequences for global economic dynamics. Ultimately, it will contribute to a deeper understanding of the importance of accurate and consistent macroeconomic measurement while also highlighting the potential challenges and trade-offs involved in this endeavor. As the most

prominent measure of economic performance, macroeconomics encompasses various concepts related to broad economic factors and outcomes.

Unlike microeconomics, which analyzes specific units like firms or consumers (Kenton, 2022; Machovec, 1995; Novshek, 1985; Charlton, 2023), macroeconomics focuses on economy-wide phenomena at the global, regional, or national level. Aside from this wider scope, three critical concepts that play an essential role in macroeconomics are inflation, unemployment, and economic growth. These key indicators form the backbone of the macroeconomic structure and drive major policy decisions that impact national and global economic movements. Properly measuring and understanding factors like unemployment, inflation, and GDP growth rates is essential for governments and organizations looking to promote large-scale economic stability and progress.

Methods

This literature review begins by assessing current mainstream news and academic works to identify high-priority economics research areas. Given the vastness of economics sub-disciplines, the objective is to determine key topics of scholarly and policy interest. Initial scans of popular media coverage and databases like Google Scholar revealed attention around macroeconomics, behavioral economics, and the role of political interests in economic data.

Therefore, we conducted a systematic literature search across academic databases, including EconLit, JSTOR, and Web of Science, to gather relevant global studies on these topics published from 1985 to 2023. The search incorporated key terms related to macroeconomic statistics, calculation debates, political influences, real-world economic impacts, technological advancements, and behavioral insights. The goal was to collect a range of high-quality scholarly articles, books, and reports encompassing fields like macroeconomics, econometrics, political economy, and behavioral economics. Through this search process and supplemental citation tracing of relevant works, 40 sources spanning economic theory, mathematical models, policy analyses, and case studies were compiled. Each piece was examined for research rigor, theoretical significance, and applicability to this analysis on interplays between economic data, politics, technology, behavior, and stability. From these sources, key empirical findings, debates, and gaps were identified, allowing refinement of the central research question on measurement issues in macroeconomic indicators and their broader implications.

In summary, initial environmental scanning of economics topics and databases guided the systematic collection of literature around issues tying economic data integrity to political interests, technological advancements, behavioral factors, and governance outcomes. Careful source analysis enabled the formulation of a targeted research focus and identification of methodologies for further examination of themes related to the politicization and evolution of economic statistics in an increasingly complex and interconnected world.

Analysis

The literature reviewed in this paper examines the interplay between macroeconomic measurement, political influences, methodological approaches, technological advancements, and

behavioral insights. The ongoing debates surrounding the calculation of key macroeconomic indicators have significant implications for economic policymaking, stability, and global affairs. By critically analyzing the historical evolution, political dimensions, methodological choices, and emerging trends in macroeconomic measurement, this literature sheds light on the challenges and opportunities for developing more accurate, comprehensive, and socially relevant indicators of economic performance and well-being. The following analysis delves deeper into this diverse body of research's key themes, findings, and implications.

A. Measurement Debates

The ongoing debates surrounding the measurement and calculation of macroeconomic metrics have far-reaching implications for policymaking, economic stability, and global affairs. As Coyle (2014) argues, the evolution of economic measurement has been shaped by the emergence of new theories, statistical methods, and national accounting systems. However, choosing specific measurement approaches, formulae, and data inputs can lead to significant variations in macroeconomic outcomes, such as inflation rates, unemployment figures, and growth estimates. These measurement debates are not just technical discussions but have deep real-world consequences. For instance, the way in which inflation is measured can directly impact monetary policy decisions, such as interest rate adjustments by central banks (Bernanke & Mishkin, 1997). Similarly, the choice of methodology for calculating unemployment rates can influence public perceptions of the labor market and shape government responses, such as unemployment benefits or job creation programs (Card, 2011).

Moreover, measuring economic growth through indicators like Gross Domestic Product (GDP) has come under scrutiny for its limitations in capturing important aspects of well-being, such as income inequality, environmental sustainability, and social progress (Stiglitz et al., 2010). Alternative measures, such as the Human Development Index (HDI) or the Genuine Progress Indicator (GPI), have been proposed to provide a more comprehensive assessment of economic and social development (United Nations Development Programme, 2022; Kubiszewski et al., 2013).

B. Political Influences

The interpretation and utilization of macroeconomic data are not immune to political influences and agendas. As Fioramonti (2017) argues, the calculation and framing of GDP figures often align with political motives rather than objective accuracy. Governments may strategically adjust or present macroeconomic indicators to paint a more favorable picture of economic performance, downplay economic challenges, or justify specific policy decisions. These political influences on macroeconomic measurement can significantly affect public trust, economic stability, and international relations. For instance, the manipulation of inflation figures by the Argentine government under former President Cristina Fernández de Kirchner led to a loss of credibility in official statistics, market distortions, and tensions with international financial institutions (Cavallo, 2013).

Political pressures can also shape the choice of macroeconomic indicators and their relative emphasis in policymaking. For example, the focus on GDP growth as the primary measure of economic success has been criticized for neglecting distributive concerns and environmental externalities (Stiglitz, 2020). The prioritization of certain metrics over others can reflect the political priorities and values of governments and influence the allocation of resources and policy interventions. Furthermore, the political economy of macroeconomic measurement extends beyond domestic contexts and has implications for global economic governance. The selection and interpretation of macroeconomic indicators by international organizations, such as the International Monetary Fund (IMF) or the World Bank, can shape the conditionality of financial assistance programs and influence the economic policies of recipient countries (Dreher, 2009).

C. Methodological Approaches

The studies reviewed in this literature employ a range of methodological approaches to investigate the relationship between macroeconomic metrics and political choices. Coyle (2014) adopts a historical and conceptual lens, tracing the evolution of GDP measurement and its limitations over time. This approach provides valuable insights into the broader context and intellectual foundations of macroeconomic measurement, shedding light on the historical contingencies and theoretical assumptions that have shaped the development of key indicators.

Fioramonti (2017), on the other hand, combines qualitative case studies with quantitative data analysis to examine the political dimensions of GDP calculations across different countries. The use of case studies allows for a more in-depth exploration of the specific political, institutional, and societal factors that influence the measurement and interpretation of macroeconomic data in particular contexts. However, the reliance on a limited number of cases may limit the generalizability of the findings to other settings (Gerring, 2017). Other studies in the literature employ econometric techniques to analyze the relationship between macroeconomic indicators and political variables. For instance, Alesina, Cohen, and Roubini (1993) use time-series analysis to investigate the political determinants of macroeconomic policies in OECD countries. While such quantitative approaches can provide valuable insights into the statistical associations between variables, they may not fully capture the complex causal mechanisms and contextual factors at play (Hoover, 2001).

Moreover, some studies rely heavily on secondary data sources, such as national statistical agencies or international organizations, which may not always ensure consistent measurement practices or data quality across contexts (Jerven, 2013). The use of secondary data also limits the ability to interrogate the underlying assumptions and methodological choices behind the construction of macroeconomic indicators.

D. Technological Advancements

In recent years, technological advancements have played an increasingly important role in shaping the landscape of macroeconomic measurement and analysis. Big data analytics, for instance, has emerged as a powerful tool for processing and deriving insights from vast amounts

of economic data (Tsai et al., 2014). The ability to harness large-scale, real-time data from various sources, such as social media, satellite imagery, or digital transactions, can provide a more granular and timely understanding of economic dynamics and complement traditional macroeconomic indicators (Einav & Levin, 2014). Moreover, machine learning techniques and artificial intelligence (AI) are being increasingly employed to improve the accuracy and efficiency of economic forecasting and policy analysis (Athey, 2018). These computational methods can help identify complex patterns and relationships in economic data, uncover hidden trends and anomalies, and simulate the potential impacts of different policy scenarios (Mullainathan & Spiess, 2017). Furthermore, the increasing reliance on digital technologies and platforms in economic activities and transactions can create new forms of inequality, exclusion, and vulnerability that may not be adequately captured by traditional macroeconomic indicators (Eubanks, 2018). The digital divide, algorithmic discrimination, and the concentration of market power in the hands of a few tech giants are some of the emerging issues that require a more inclusive and equitable approach to macroeconomic measurement and policy (Zuboff, 2019).

While technological advancements offer promising opportunities for enhancing the scope, granularity, and timeliness of macroeconomic measurement, they also call for a more critical and reflexive engagement with their limitations, biases, and societal implications. Economists, policymakers, and other stakeholders need to collaboratively develop and implement appropriate governance frameworks, ethical guidelines, and methodological standards to ensure that these technologies are harnessed in a responsible, transparent, and accountable manner.

E. Behavioral Insights

Another important strand of research that has gained prominence in recent years is the integration of behavioral insights into macroeconomic analysis and policymaking. Traditional macroeconomic models often rely on the assumption of rational, utility-maximizing agents with perfect information and foresight. However, a growing body of evidence from behavioral economics suggests that individuals often exhibit bounded rationality, cognitive biases, and heuristics in their decision-making processes, which can lead to systematic deviations from the predictions of standard economic models (Kahneman, 2011).

Incorporating these behavioral insights into macroeconomic analysis can provide a more realistic and nuanced understanding of how individuals, firms, and institutions respond to economic incentives, shocks, and policies. For instance, behavioral models of consumption and saving can help explain the observed patterns of household financial behavior, such as the tendency to underestimate future expenses or the reluctance to adjust spending habits in response to income shocks (Laibson, 1997; Thaler & Benartzi, 2004). However, the integration of behavioral insights into macroeconomic analysis and policy also presents some challenges and limitations. The external validity and scalability of behavioral interventions need to be carefully assessed, as the effectiveness of specific nudges or choice architectures may vary across different contexts and populations (Deaton & Cartwright, 2018).

Discussion

The literature reviewed in this paper sheds light on the complex and multifaceted nature of macroeconomic measurement and its interplay with political influences, methodological choices, technological advancements, and behavioral insights. The findings have important implications for policymaking, economic stability, and global affairs in an increasingly interconnected world.

First, the ongoing debates surrounding the measurement and calculation of macroeconomic indicators underscore the need for a more critical and reflexive approach to economic analysis. The choice of specific measurement approaches, formulae, and data inputs can lead to significant variations in macroeconomic outcomes, with far-reaching consequences for monetary policy, public perceptions, and government responses (Bernanke & Mishkin, 1997; Card, 2011). Policymakers and economic institutions need to be more transparent about the assumptions, limitations, and potential biases underlying their preferred indicators and engage in more inclusive and participatory economic governance processes (Hoekstra, 2019).

Second, the literature highlights the pervasive influence of political factors on the interpretation and utilization of macroeconomic data. Governments may strategically adjust or frame macroeconomic indicators to advance their political agendas, justify policy decisions, or downplay economic challenges (Fioramonti, 2017). These political pressures can shape the prioritization of certain metrics over others, reflecting the values and priorities of those in power. To counter these influences, there is a need for more independent and objective sources of economic data, as well as stronger institutional safeguards and accountability mechanisms to prevent the manipulation or misuse of macroeconomic information (Cavallo, 2013).

Third, the review underscores the importance of methodological pluralism and interdisciplinary collaboration in macroeconomic analysis. Different methodological approaches, such as historical analysis, case studies, econometric techniques, and behavioral models, can provide complementary insights into the complex dynamics of macroeconomic systems (Coyle, 2014; Fioramonti, 2017; Laibson, 1997). However, each approach has its own strengths and limitations, and researchers need to be more explicit about the assumptions, data sources, and potential biases underlying their chosen methods. Moreover, economists need to engage more systematically with insights from other social science disciplines, such as political science, sociology, and psychology, to develop a more holistic and contextually grounded understanding of economic phenomena (Colander & Kupers, 2016).

Fourth, the literature points to the transformative potential of technological advancements, such as big data analytics, machine learning, and artificial intelligence, for enhancing macroeconomic measurement's scope, granularity, and timeliness (Athey, 2018; Einav & Levin, 2014). These technologies can help uncover new sources of economic data, identify complex patterns and relationships, and simulate the potential impacts of different policy scenarios. However, they also raise important questions about data privacy, algorithmic bias, and the equitable distribution of the benefits and risks of these innovations (Eubanks, 2018; Zuboff, 2019).

Conclusion

This paper provides an exploratory yet comprehensive and nuanced understanding of the interplay between macroeconomic measurement, political influences, methodological approaches, technological advancements, and behavioral insights. The findings show the importance of accurate, transparent, and accountable measurement of macroeconomic indicators, as they play a crucial role in shaping policy decisions, economic stability, and global affairs (Coyle, 2014; Fioramonti, 2017). The review also highlights the inherent challenges and limitations in this endeavor, given the various political and economic factors that influence the calculation and interpretation of these metrics (Cavallo, 2013; Dreher, 2009). The empirical evidence suggests that variations in macroeconomic measurement can have significant real-world impacts, with a bi-directional relationship between macroeconomic dynamics and geopolitical tensions (Caldara & Iacoviello, 2018; Rodrik, 2018).

Recent technological advancements, such as big data analytics, machine learning, and artificial intelligence, offer promising opportunities for enhancing the scope, granularity, and timeliness of macroeconomic measurement and analysis (Athey, 2018; Einav & Levin, 2014; Tsai et al., 2014). They raise important challenges and considerations regarding data quality, representativeness, interpretability, and ethical implications that require a critical and reflexive approach (Eubanks, 2018; Zuboff, 2019). Also, integrating behavioral insights into macroeconomic analysis and policy provides a more realistic and nuanced understanding of how individuals, firms, and institutions respond to economic incentives, shocks, and policies (Kahneman, 2011; Laibson, 1997; Thaler & Benartzi, 2004). The application of behavioral theories and tools to macroeconomic contexts also requires a cautious and rigorous approach that carefully considers the limitations, challenges, and ethical implications (Deaton & Cartwright, 2018).

In conclusion, the overarching literature examined in this paper calls for a paradigm shift in the way we understand and shape the complex interactions between economics and politics in a globalized world. It emphasizes the need for a more holistic, adaptive, and inclusive approach to economic analysis and policymaking, one that recognizes the multidimensional nature of well-being, the geopolitical dimensions of economic dynamics, and the importance of democratic participation and accountability in economic governance (Colander & Kupers, 2016; Hoekstra, 2019). We can build a more resilient, equitable, and prosperous global economy for all by embracing a more multidimensional and participatory approach to economic analysis and governance.

Limitations

While the literature reviewed in this paper provides valuable insights into the complex interplay between macroeconomic measurement, political influences, methodological approaches, technological advancements, and behavioral insights, there are several limitations to consider. As this paper is exploratory, the empirical evidence found on these interactions still needs to be expanded as they are often context-specific. More research is needed to unpack the causal mechanisms and boundary conditions that shape these relationships across different

settings. Additionally, the literature on technological advancements and behavioral insights in macroeconomic analysis and policy is somewhat new. Based on current literature, it is constantly evolving, requiring further theoretical and empirical work to develop robust frameworks and methodologies for integrating these new approaches into traditional macroeconomic models and policies while carefully evaluating their limitations, challenges, and ethical implications.

Future Directions

To address these limitations and build upon the findings of this literature review, future research could expand the scope to include a broader range of disciplines and methodological approaches, employ more rigorous meta-analytic techniques to quantitatively synthesize the findings across studies, and use more sophisticated models or experimental designs to understand better the causal relationships between these variables (Card & Krueger, 1995). Another important avenue for future research could examine the potential of big data and machine learning techniques to improve the accuracy and timeliness of macroeconomic measurement while also considering the ethical and privacy implications of these approaches (Einav & Levin, 2014).

Future research should also aim to develop large-scale and long-term behavioral interventions and policy experiments, as well as more models and simulations that can capture the interactions between individual behaviors and aggregate economic outcomes (Benartzi et al., 2017; Kahneman, 2011; Thaler & Benartzi, 2004). The research should also focus on developing practical tools and frameworks. This could involve creating decision support systems, scenario planning tools, or policy evaluation frameworks integrating insights from multiple disciplines (Colander & Kupers, 2016; Kaplan & Norton, 1992). By bridging the gap between research and practice, these efforts can contribute to more informed and effective decision-making in the face of global economic and geopolitical challenges.

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Works Cited

Aguilar, P., Briceño, A., Casarin, N., de Moraes, J., Milea, C., & Philippon, T. (2021). Macroeconomic, social and environmental impacts of a circular economy up to 2050: A meta-analysis of prospective studies. Journal of Cleaner Production, 278, 123421. https://doi.org/10.1016/j.jclepro.2020.123421

Alesina, A., Cohen, G. D., & Roubini, N. (1993). Electoral business cycle in industrial democracies. European Journal of Political Economy, 9(1), 1-23

Allcott, H., & Mullainathan, S. (2010). Behavior and energy policy. Science, 327(5970), 1204–1205. https://doi.org/10.1126/science.1180775

Athey, S. (2018). The impact of machine learning on economics. In A. K. Agrawal, J. Gans, & A. Goldfarb (Eds.), The economics of artificial intelligence: An agenda (pp. 507–547). University of Chicago Press.

Benartzi, S., Beshears, J., Milkman, K. L., Sunstein, C. R., Thaler, R. H., Shankar, M., Tucker-Ray, W., Congdon, W. J., & Galing, S. (2017). Should governments invest more in nudging? Psychological Science, 28(8), 1041–1055. https://doi.org/10.1177/0956797617702501

Bernanke, B. S., & Mishkin, F. S. (1997). Inflation targeting: A new framework for monetary policy? Journal of Economic Perspectives, 11(2), 97–116.

Börzel, T. A., & Risse, T. (2016). Studying macroeconomic indicators as powerful ideas. Journal of European Public Policy, 23(3), 410-427. https://doi.org/10.1080/13501763.2015.1115537

Caldara, D., & Iacoviello, M. (2018). Measuring geopolitical risk. International Finance Discussion Papers, Board of Governors of the Federal Reserve System, (1222). https://doi.org/10.17016/IFDP.2018.1222

Card, D. (2011). Origins of the unemployment rate: The lasting legacy of measurement without theory. American Economic Review, 101(3), 552–57.

Card, D., & Krueger, A. B. (1995). Time-series minimum-wage studies: A meta-analysis. The American Economic Review, 85(2), 238-243.

Cavallo, A. (2013). Online and official price indexes: Measuring Argentina's inflation. Journal of Monetary Economics, 60(2), 152–165.

Charlton, K. (2023). What is a perfectly competitive market? Semrush Blog. https://www.semrush.com/blog/what-is-a-perfectly-competitive-market/

Colander, D., & Kupers, R. (2016). Complexity and the art of public policy: Solving society's problems from the bottom up. Princeton University Press.

Coyle, D. (2014). GDP: A brief but affectionate history. Princeton University Press.

de Siqueira, Julio Homem, Andrew G. Mtewa, and Daury César Fabriz. "United Nations Development Programme (UNDP)." International Conflict and Security Law: A Research Handbook. The Hague: TMC Asser Press, 2022. 761-777.

Deaton, A., & Cartwright, N. (2018). Understanding and misunderstanding randomized controlled trials. Social Science & Medicine, 210, 2–21. https://doi.org/10.1016/j.socscimed.2018.05.015

Dreher, A. (2009). IMF conditionality: Theory and evidence. Public Choice, 141(1-2), 233–267.

Einav, L., & Levin, J. (2014). Economics in the age of big data. Science, 346(6210), 1243089. https://doi.org/10.1126/science.1243089

Eubanks, V. (2018). Automating inequality: How high-tech tools profile, police, and punish the poor. St. Martin's Press.

Fioramonti, L. (2017). The world after GDP: Politics, business and society in the post growth era. Polity Press.

Fischer, S. (1991). Growth, macroeconomics, and development. NBER Macroeconomics Annual, 6, 329–379. https://doi.org/10.1086/654179

Gerring, J. (2017). Case study research: Principles and practices (2nd ed.). Cambridge University Press.

Hoekstra, R. (2019). Replacing GDP by 2030: Towards a common language for the well-being and sustainability community. Cambridge University Press.

Hoover, K. D. (2001). Causality in macroeconomics. Cambridge University Press.

Jerven, M. (2013). Poor numbers: How we are misled by African development statistics and what to do about it. Cornell University Press.

Kahneman, D. (2011). Thinking, fast and slow. Farrar, Straus and Giroux.

Kaplan, R. S., & Norton, D. P. (1992). The balanced scorecard: Measures that drive performance. Harvard Business Review, 70(1), 71–79.

Karabell, Z. (2020). The leading indicators: A short history of the numbers that rule our world. Simon & Schuster.

Kenton, W. (2022). Microeconomics definition, uses, and concepts. Investopedia. https://www.investopedia.com/terms/m/microeconomics.asp

Kubiszewski, I., Costanza, R., Franco, C., Lawn, P., Talberth, J., Jackson, T., & Aylmer, C. (2013). Beyond GDP: Measuring and achieving global genuine progress. Ecological Economics, 93, 57-68. https://doi.org/10.1016/j.ecolecon.2013.04.019

Laibson, D. (1997). Golden eggs and hyperbolic discounting. The Quarterly Journal of Economics, 112(2), 443–478. https://doi.org/10.1162/003355397555253

Machovec, F. M. (1995). Perfect competition and the transformation of economics. Routledge.

Mullainathan, S., & Spiess, J. (2017). Machine learning: An applied econometric approach. Journal of Economic Perspectives, 31(2), 87-106.

Novshek, W. (1985). Perfectly competitive markets as the limits of Cournot markets. Journal of Economic Theory, 35(1), 72–82. https://doi.org/10.1016/0022-0531(85)90086-8

Rodrik, D. (2018). Populism and the economics of globalization. Journal of International Business Policy, 1(1-2), 12–33.

Stiglitz, J. E. (2020). Measuring what counts: The global movement for well-being. The New Press.

Stiglitz, J. E., Sen, A., & Fitoussi, J.-P. (2010). Mismeasuring our lives: Why GDP doesn't add up. The New Press.

Thaler, R. H., & Benartzi, S. (2004). Save More Tomorrow: Using behavioral economics to increase employee saving. Journal of Political Economy, 112(S1), S164-S187.

Tsai, C. H., Lin, C. J., & Tjoa, A. M. (2014). Big data analytics: A literature review paper. In Advances in Data Mining. Applications and Theoretical Aspects (pp. 174-187). Springer. https://doi.org/10.1007/978-3-319-08976-8_16

Zuboff, S. (2019). The age of surveillance capitalism: The fight for a human future at the new frontier of power. Public Affairs.

"The impact of societies on characters' self-isolation practices in Taylor Swift's The Archer and Amy Sherman Palladino's Gilmore Girls" By María Vieytez

I.   Introduction:

"The loneliness of social isolation is initiated by the absence of socially integrative relationships"[1]. As stated by psychotherapist Robert Weiss, a community lacking integrative bonds --or a judgemental society-- forces its members into a cycle of self-isolation, as it shields individuals from betrayal. Said coping mechanism has prevailed through generations facing a variant of the condemning society, reflected in contextually differing literary productions sharing the character of the isolated misfit amidst an internal battle between forming trusting relationships and self-preservation. It is through these texts --in this essay's instance, The Archer[2] (song) by Taylor Swift and Gilmore Girls[3] (show) by Amy Sherman-Palladino-- that the timelessness of this lonely battle is demonstrated, as an individual's protection from betrayal will exist independently of leading a private life within a 90s Connecticut small-town, or a 21st century fame exposure world, so long as the surroundings threaten social survival.

Within the latter text, Gilmore Girls, this "threatened" individual appears as the secondary character, Paris Geller, who isolates because of the parental neglecting environment she developed in. Although this series was aired in seven seasons from 2000-2007, it shares the feature of the misfit's struggle with Taylor Swift's The Archer, released almost twenty years after the show. As part of Swift's album, Lover[4], this single reflects isolation as the harmful tool stemming from the fluctuating public eye-- although some pre-existing interpretations hold that Swift's track recognizes her faults with self-sabotaging, which will be briefly explored.

Given that these texts demonstrate the interference of characters' societies on their ability creating integrative bonds, they are sources of importance to answer: **To what extent are the societies portrayed in Taylor Swift's song, The Archer and Amy Sherman Palladino's show, Gilmore Girls responsible for characters' social self-isolation?**

This will be explored with the content gathered through the method of investigation of the analysis of both texts as primary sources, along with Gilmore Girls' revival, Gilmore Girls: A Year in The Life[5]. Interviews with Liza Weil[6] – actress with Paris' role—and Swift's documentary, Miss Americana[7] will also be analysed as secondary sources. The investigation will hold two focuses on themes and characters: the betrayal and hypocrisy within society, and the defence mechanism of "they see right through me"[8].

Seeing that isolation is a chief issue in characters' lives, the worthiness of studying this aspect lies on discovering to what extent alienation is a result of the judgement within society, or if it relies on the characters' individual responses. Additionally, the topic for this Extended Essay was chosen given that this issue transcends fiction, and although based on fictional texts, it prevails in modern society. This EE strives to shed light on why self-isolation takes place regardless of a character's setting.

II.   Context of Production

i.   The Archer

Ever since Taylor Swift rose to fame in 2006 with her self-titled debut album[9], she has been exposed to a fluctuating fanbase. Along with 99.3 million monthly listeners on Spotify[10], comes a battle that Swift described in a 2019 Vogue interview as "a mass public shaming… a very isolating experience."[11].

Two months before said interview, The Archer was released, a song in which the isolation during Swift's "Lover era" as protection from "cancel culture" was reflected. Swift's producer, Jack Antonoff, is recognized for his handling of musicians' emotional vulnerability, and it is inferred that with The Archer, Swift was compelled to reminisce her 2016 incident with Kanye West: an inappropriate mention of Swift in the rapper's song Famous[12]. The media responded by creating #TaylorSwiftIsOverParty, a Twitter trend through which her condemning society celebrated her fame's demise. Resultingly, Swift alienated by becoming inactive on social media until 2020, when her documentary Miss Americana was released, stating that her isolation was "happiness without anyone else's input"[13]; a social distance illustrated in The Archer.

The musical world welcomed The Archer as Swift's cry for help on how a betraying society generated a fear of allowing people to "see right through" her, reaching the US Billboard Hot 100 at spot 69, peaking at 38[14].

ii.   Gilmore Girls

Gilmore Girls was released in 2000, depicting the small-town life of Lorelai Gilmore and her sharp-witted daughter, Rory Gilmore. The show is referenced as a reflection of the feminist movement, since the writer, Palladino, had worked on Roseanne[15] (1988), a "canonised feminist-leaning"[16] show, keeping the mastery of illustrating women's strengths on screen. This portrayal of female realities is what brought Gilmore Girls sixteen nominations in the OFTA Television Awards from 2001 to 2006[17].

"I threw in this one idea about a mother and daughter who are more like friends than mother and daughter… I didn't have a show, mind. I had a relationship." [18] shared Palladino in her AV Club interview, on the origin of Gilmore Girls' idea.

Gilmore Girls' success led to a demand for an eighth season of the show, fulfilled in 2016 with Gilmore Girls: A Year in The Life. The four 90-minute episodes portray the iconic characters, ten years later.

Amongst these characters, Paris Geller stands out as Rory's foil: a 'misfit', thriving on academic excellence while neglecting genuine bonds with society. Although often seen as the eccentric 'mad-woman', what goes unnoticed, is that Paris' personality is a façade, born from a hypocritical relationship with her parents, and the expectations set upon her. Resultingly, Paris became afraid of letting others "see through her", creating an image of the bossy academic.

III.   Self-isolation in Both Texts

i.   Irony and paradoxes in hypocritical societies

Both in The Archer and Gilmore Girls antitheses, irony, and paradoxes are crucial to reflecting the condemning societies' hypocrisy and its effect on characters' isolation.

Regarding the former, the lyrical body illustrates the duality within society and the narrator. Quoting the opening line, "I'm ready for combat/ I say I don't want that, but what if I do?"[19] portrays the internal fluctuation the misfit suffers, as it senses it must remain on guard to protect from society's betrayal, appearing as dual when meaning to establish healthy relationships. This ambivalence roots from the dichotomous society depicted by Swift as "easy they come, easy they go"[20], which leads to the self-isolation portrayed in the following lyric, "I jump from the train, I ride off alone"[21]. In The Archer's final lyrics, this theme rekindles as Swift repeats the rhetorical question "who could stay?", that she then answers with a parallel, reassuring that "you could stay". However, when it appears that the narrator establishes a lasting relationship, the track ironically closes by returning to the opening phrase "combat, I'm ready for combat", coming full-circle, signifying that the cycle of isolation is eternal and omnipresent.

With The Archer, Swift recognizes the sabotaging dynamic between the abandoning society and the targeted individual, stating that "I've been the archer, I've been the prey"[22]. This paradox in her narrative alerts audiences of the ironic relationship between the opposite archer and prey; having once been society's prey, one isolates to avoid condemnation, and becomes a defensive archer by abandoning relationships, depicting the inherently illogical issue behind isolating— created by society's betrayal. Then, the reason for the archer metaphor becomes clear, as this character relies on a long-distance weapon to harm others while secluded.

Although pre-existing interpretations of this track – to which, upon evaluation, there are only non-reliable Twitter "threads"[23] -- suggest that The Archer reflects Swift owning up to her self-sabotage in relationships, her lyricism repeatedly referrs to her society as "they" when stating "easy they come easy they go"[24] and addresses her audience with the inclusive pronoun in "help me hold on to you"[25], directing her listeners' attention to the society described within the lyrics, evidencing that the track targets society as mainly responsible for her isolation.

Additionally, the method of a scrutinizing analysis regarding the use of antithesis and metaphors furthers the understanding that the song appoints society as accountable for Swift's isolation, as paradoxes portray society's inherent betrayal from the insightful perspective of Swift's first-person narration as the misfit. Swift places herself as the track's subject, becoming aware to society's influence in her alienation. Hence, The Archer communicates the singer's isolationist insecurities around a society allegedly responsible for her alienation.

Exploring Gilmore Girls with this focus, the paradox and betrayal become most evident in Paris' mother's single appearance. Although Paris clarifies that her parents are distant --like in season 1 episode 13 where she states that "I wonder if I was missing if my mom would come looking for me"[26]-- it is until Mrs. Geller's ironic behaviour is portrayed on screen, that the depth of Paris' society's hypocrisy is perceived, and subsequently, her isolation and anxious-avoidant attachment style.

This scene is featured on season 1, episode 11[27], "Paris is Burning", when it is 'bring your parent to school day'.

Image 1.[28]

Image 2[29]

Initially, Paris asks her mother to stay "at least for lit class"[30], but, ironically, Mrs. Geller interrupts Paris by scolding her for not using her prescribed cleanser. The situational irony of focusing on her looks portrays the hypocrisy in Paris' society. A juxtaposition also works with presenting the personalities side by side, enhancing both; Paris gives the rightful importance to her academics, while her mother focuses on vain idiosyncrasies. This roots from the 2000s' third feminist wave, as activists used the Internet as a forum to abolish gender stereotypes through exposure. Within this scene, Mrs. Geller works as the conventional image of a conceited woman, which Palladino rejects by contrasting her with Paris, who embodies the integral ideal of a modern woman, enhancing her academic façade.

Furthermore, the camera's positioning creates a contrast between the characters; the lighting gives Mrs. Geller the appearance of towering over Paris, as shadows hit her face, making the audience perceive her as evil. The disparity in lighting then gives Paris' vulnerable expression a bright appearance, as she is the exposed victim struggling to isolate. When the camera faces Paris, the viewer perceives her mother's profile and shadow haunting over the smaller person, conveying the omnipresence of her mother's judgement. Additionally, Paris' grip onto her bag –symbolizing her façade-- exposes her anxious attachment style, as she isolates behind her academic validation when threatened, a mannerism that prevails throughout the show.

Overall, in both texts, contrasting two elements is crucial to reflecting society's betrayal, which directly triggers self-isolation in avoiding vulnerability through distancing from emotional bonds. In The Archer, this is done through antithesis and paradox that represent hypocrisy in mass media, and Swift's abandonment of relationships. In Gilmore Girls, this is done with irony and contrasts in camerawork amongst Paris' dual community.

ii.   "They see right through me": a defence mechanism.

In The Archer and Gilmore Girls, the featured character fears forming integrative relationships, as they isolate behind an image masking their vulnerability. The characters' fluctuating societies instilled a fear of allowing others to "see right through" them, as they sense that, if an outsider becomes aware of the character's weaknesses, inherent betrayal will bring society to abandon them. Therefore, the theme of "they see right through me" is a motif in both texts as Swift and Paris share the practice of isolating by prohibiting others from knowing their negative tendencies.

Regarding The Archer, "they see right through me"[31] is the central lyric to conveying the struggle behind isolation, included as a repetition in the song's bridge. Before this verse, the track maintains a midtempo rhythm, as it builds up to a beat drop, reflecting the tension that accumulates within isolation, foreseeing the moment the façade falls. During the bridge however, the beat intensifies, and "they see right through me"[32] engages with repetition to bring the rhythm and lyricism together, emphasizing on the isolating anxiety that then surfaces the question "can you see right through me?"[33]. This transition of the repeated lyric shows how fear within a relationship leads to doubts in every connection that could potentially reach the isolating individual on a deeper level, to then betray them. A study from the New York Academy of Sciences showed that "isolation heightens sensitivity to social threats (predator evasion)"[34],

which can be directly linked to Swift's manifestation of the rutinary fear of being seen through by social threats as predators, heightening the prey's doubts, reflected through the augmenting repetition wondering if society can see "right through" Swift. Suddenly, the narrative's peripeteia is reached with Swift's transition from "they see right through me" to "I see right through me"[35]. With the subject change, Swift conveys a self-realization within isolation: while hiding insecurities from others, the isolating individual suppresses their negative dimension until it becomes foreign to themselves. The problem of isolation deepens when, having neglected an internal fault, the isolating individual forsakes potential development, and prohibits others to aid in personal improvement. In this moment, Swift realizes that one cannot maintain superficiality in relationships, for a person's weaknesses will persevere without acknowledgement, and loneliness will become rutinary. Overall, the repetition "they see right through me"[36] is the reflection of the anxiety within isolation that has its roots in judgmental societies, since it is due to them that a character suppresses their negative traits behind a mask.

As mentioned above, Paris develops an academic façade to conceal her abandonment insecurity. Paris isolates from relationships by neglecting genuine bonds that "see right through her"; she fears that when developing a profound attachment beyond scores and awards—her one value--, her unpleasant personality will break relationships. It is inferred that this isolation originates from the hypocritical society she has been brought up in, as people will only accompany her in success.

Therefore, when Paris faces the Harvard rejection[37], the results wreck her, since she is dependent on academic validation, hoping it meant social acceptance. Throughout Gilmore Girls, Paris invests years into collegiate perfection, primarily presented in season 2, episode 2[38]. Through the syntax of enlisting with commas and fast-paced speech, Paris explains that "I've been a camp counsellor, I organized a senior literacy program, I worked a suicide hotline, I manned a runaway centre, I've adopted dolphins, taught sign language…". With an asyndeton, audiences perceive an overwhelming grandness of Paris' achievements, and sympathize with her by pondering on how she could have been denied admittance. Hence, Paris' isolation through the strong academic façade proves insufficient; the perfect scores fail to protect her from being "seen through", exposing her weaknesses, creating an emotional meltdown. She then relies on another isolation mechanism: "cruelty" in relationships.

Paris' emotional fear of letting others "see through her" makes her come off as aggressive, keeping others distantly intimidated.

Even actress Liza Weil admits that "I remember it being difficult for me to find where her behaviour was coming from, because in the beginning, Paris does present as this very mean and confrontational…[person]… a lot of that stuff comes out of the need of wanting to belong and being insecure"[39]. This is observed in season 1, episode 11[40], when Paris spreads the rumour of her friend Rory's mother dating a teacher. While Paris deals with her parent's divorce, she must detour the attention from her problems, which is why she attacks Rory's mom; she isolates by attacking others like an archer. One initially assumes that Paris is unremorsefully cruel, but once her defensive cover-up shatters –as Rory confronts her—the viewer understands Paris' nature.

WHAT IS WRONG WITH YOU?

NOTHING, I'M GREAT

Image 3[41].

When Rory approaches Paris, the latter maintains a confident appearance, with a smirk and firm gaze on Rory; she also grips onto her bag across her chest, as a symbol of her protective academic "shield". Nonetheless, as Rory remarks that "you [Paris] turn around and pull something like this? Doesn't that seem crazy to you"[42], Paris' expression alters:

DO YOU HAVE ANY IDEA
HOW MANY PEOPLE YOU'VE HURT?

Image 4[43]

Regret settles as Paris admits that "things have been… not good lately. I just didn't want them talking about me anymore…"[44]. Paris then avoids eye contact, and her smirk disappears as she realizes that her actions have been another ambushing isolation episode, pushing people away to defend herself. Even after Paris exhibits her vulnerability, she reassures that her and Rory "are not friends"[45], since she is still afraid to let others "see through her".

A second instance where Paris isolates due to relational threats is in the episode "Love, Daisies, and Troubadours"[46], in which she encounters rumours that Rory has betrayed her by being involved with her love interest.

In this interaction, Paris confronts Rory by hinting that she knew about what the "traitor"[47] had done, without addressing the situation, hoping Rory will admit her mistake so she maintains the lead in discourse, attacking as an archer. She further explains that her mistake was "letting her guard down"[48], relying on her façade, and Rory's, "making enemies where you [Rory] should've made friends"[49]. Rory, unaware, questions how she had turned Paris into her enemy.

WAS IT SETTING YOU UP
WITH TRISTIN?

Image 5[50]

As a response to Rory's uncertainty, Paris faces away, as she often does in confrontations, replying, "I think you know"[51], again taking an isolating stance instead of allowing her friend to "see through her" and comprehend her vexation. Paris escapes the friendship, turning Rory into an enemy, distantly hiding her jealousy as to not be abandoned, but be the one to abandon. She "jumps off the train and rides off alone"[52] as "all of my (Paris') enemies started out friends"[53].

After Paris explains why she is condemning Rory, she refuses to discuss it; she relies on attacks and employs her academic façade as a threat. Paris warns Rory: "Worry. I just got the

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job"[54], referring to the Newsletter editor. As she makes this poignant statement, –enhanced by the punctuation mark right after "worry"— she walks away with a sarcastic tone, wishing Rory a "really good summer"[55], with the final shot showing Paris gripping onto her bag, as she successfully returns to isolation.

Image 6[56].

Years posterior to their high school disputes, Paris still neglects Rory's trust; in the "Spring"[57] episode of the Gilmore Girls: A Year in The Life miniseries, Paris breaks down over meeting her former Chilton schoolmates. She storms into Chilton's bathrooms, and with a formal appearance, frantically paces in desperation and encounters distress, humorously illustrating her isolation as she behaves immaturely in a mature aspect. Paris attempts hiding the vulnerability rekindled by reminding herself of her professional success. "The advanced degrees, the academic awards, all my accomplishments… the private club, the Pilates." As a static character, Paris returns to her overachiever façade to drown her emotions out; the viewer infers this is an allusion to her past enumeration in season 2, episode 2[58] of her high school academic success. However, she now recognizes that she is "still just Paris Geller… the invisible girl"[59]. Paris finally understands that her superficial triumphs only built a perfect image that does not improve her self-esteem, since her emotions are still immaturely raw; with this realization, she admits to being pathetic, and reveals her empty briefcase.

Image 7[60]

For the first time, Paris lets Rory "see through her". Moreover, like The Archer, this is Paris' peripeteia, as she sees through herself. The briefcase returns full circle as a symbol of the academic image she built, empty when exposed. Academically wise as Paris appears, once she opens up –like the case--, her knowledge is in vain compared to the emotional intelligence she lacks. A pattern of isolation has kept her from understanding her value beyond the scores and titles. Additionally, it alludes to young Paris' schoolbag, which she would often grip when threatened as the defence isolationist mechanism, with a more mature appearance. Yet, when Paris exposes her weakness beyond the academic façade, she returns to insecurity, threatening Rory: "do not abandon me"[61]. As Paris has this self-revelation of her weaknesses, her isolation strengthens, and restraints others from the bathrooms' vicinity:

Image 8[62]

Instinctively, Paris keeps others out from her shelter in the bathrooms with Rory. Briefly, Paris shares her preoccupations with Rory, until her high school enemy, Maxine, enters. Immediately, Paris' isolation spikes as she returns to condemning others to protect herself from being "seen through".

Paris questions if Rory and Maxine are plotting against her "again", reliving past their past inconveniences. The singular person Paris trusted seconds ago, again becomes an enemy. Once Paris recovers from emotional turmoil, she pleads Rory to not "tell anyone about the briefcase"[63], since she cannot tolerate others seeing "through her", conveying that, after years of isolation, apparent maturity cannot alter cyclical behaviour.

Although it is expected that Paris should open up around Rory, as their friendship has been stable –meaning that Paris' society is not completely responsible for her isolation, for she has encountered genuine relationships--, it is evident that alienation is not dependent on selection; someone with an isolationist defence mechanism will inevitably implement it in every relationship. Since Paris' isolation comes from her childhood's parental neglect, she is unable to alter her social abilities or let Rory "see through" her without fearing betrayal, evidencing that ultimately, her society is responsible for self-isolation.

Altogether, Paris reflects through multiple stages an anxious fear of letting her condemning society "see through her", since if she loses validation, others will abandon her. Be it through a disagreeable demeanour or academic achievement, Paris' battle with isolation prevails, reflected through devices compelling the audience to ponder on her behaviour's origin. Similarly, The Archer exhibits the anxious reality behind "they see right through me"[64] as a central idea, for an isolationist person naturally fears exposing their weaknesses before a judgmental society responsible for alienation.

IV.   Conclusion

Thus, it becomes evident how social self-isolation within The Archer and Gilmore Girls entirely stems from the betraying societies that characters evolve in. Moreover, both texts depict the impact a constantly hypocritical community has on individuals' abilities to create genuine bonds. In The Archer's instance, Swift relies on antitheses, paradoxes, and irony to expose society and her internal struggles when attempting to develop trusting relationships after having been frequently betrayed by the fluctuating media. Additionally, the track embraces repetition as a tool to enhance the anxiety whenever society threatens to "see right through" the character's façade. Considering Swift's incident with West, and her exposure to the "toxic" public eye, it is no surprise that her coping mechanism consists of hiding behind the mask of the vengeful "mad-woman" in her retaliation songs. Although this personality is continually criticized, it seems better to sustain judgement upon a false personality than one's genuine weaknesses. Hence, her recurring reference to "they see right through me" and characterization of herself as an archer, a metaphor reflecting her ability to hurt traitors with a long-distance weapon from her isolation. In the case of Gilmore Girls, self-isolation is clearly exhibited through Paris' "cruel" and driven character. As a child of neglecting parents within a judgemental society, Paris' character builds an obsession to excel academically and an aggressive, unreasonable personality. However, this lack of emotional intelligence and the academic overachiever façade is limited to a manifestation of her isolationist tendencies rooted from insecurities that her community constructed. Through a juxtaposition in camera angles and characterizations, irony, fast-paced speech and short syntax, and the bag or briefcase symbol, Palladino depicted the prevalence of isolation within Paris' development. Therefore, this social inability has proven to be a response to the pressure inflicted on Paris by her judging society; only when this façade falls, the public perceives her round character's vulnerability.

Even both characters eventually share the realization that, once their façade vanishes, they are even weaker, since they have obstructed others from aiding with improvement, only possible in trusting relationships.

Having analysed both texts, it becomes clear that characters' societies remain responsible for isolation. Although it is often argued that isolation does not completely depend on society, but on an unhealthy response from the alienating character, the evidently differing personas evaluated illustrate that, regardless of their attitudes or setting, the misfit will tend to cope through a façade that debilitates relationships, evidencing that <u>society ultimately eliminates the reassurance of belonging and triggers social isolation as a natural response.</u>

Works Cited

"All 18 Songs from Taylor Swift's New Album 'Lover' Chart On the Billboard Hot 100".
     Billboard. 16 Sep. 2023.
          https://www.billboard.com/pro/every-song-taylor-swift-lover-charts-hot-100/

"Amy Sherman-Palladino" AV Club. 16 Sep. 2023.
          https://www.avclub.com/amy-sherman-palladino-1798208442

Gilmore Girls: A Year in The Life. Created by Amy Sherman-Palladino, performances by Alexis
     Bledel, Lauren Graham, and Liza Weil, Netflix, 2018.

"Gilmore Girls Awards". IMDb. 16 Sep. 2023. https://www.imdb.com/title/tt0238784/awards/

Gilmore Girls. Created by Amy Sherman-Palladino, Performances by Alexis Bledel, Lauren
     Graham, and Liza Weil, Netflix, 2000-2007.

Miss Americana. Digital. Netflix, Jan 2019.

Liza Weil Talks Gilmore Girls Revival and the Joys (and Perils) of Playing Paris the Mean Girl".
     Cosmopolitan. 16 sep. 2023.
          https://www.cosmopolitan.com/entertainment/tv/a8263650/liza-weil-gilmore-girls-intervi
          ew/

"Taylor Swift on Sexism, Scrutiny, and Standing Up for Herself". Vogue. 3 Aug. 2023
          https://www.vogue.com/article/taylor-swift-cover-september-2019

Rebooting Roseanne". MC Journal. 16 Sep. 2023.
          https://journal.media-culture.org.au/index.php/mcjournal/article/view/1472#:~:text=In%2
          0its%20original%20form%2C%20Roseanne,Slayer%20(1997%2D2004).

Roseanne. Television, Viacom, 1988.

"Social Isolation". The New York Academy of Sciences. 8 jun.
     2011.https://nyaspubs.onlinelibrary.wiley.com/doi/abs/10.1111/j.1749-6632.2011.06028.x

Swift, Taylor. Lover. Republic Records, 2019.

Swift, Taylor. Taylor Swift. Big Machine Records, 2006.

Swift, Taylor. The Archer. Electric Lady, 2019.

"Taylor Swift". Spotify. 3 Aug. 2023
          https://open.spotify.com/artist/06HL4z0CvFAxyc27GXpf02

Twitter. 10 Aug. 2023 https://twitter.com/?lang=es

Weiss, Robert. Loneliness: The Experience of Emotional and Social Isolation. Cambridge, Mass:
     The MIT Press, April 15, 1975.

West, Kanye. Famous. GOOD company, 2016.

The Airfoil of an Aircraft By Hongyi Zhao

In this paper, I speak about the airfoil shape and its relation to lift and drag generation. First, I start by talking about the four applied forces on an aircraft. Then, I explain how the airfoil generates lift. Thirdly, I talk about the shape characteristics of an airfoil. Finally, I talk about how NASA came up with airfoil nomenclature and tested different airfoil shapes in wind tunnels.

An aircraft is affected by four forces when it is flying, thrust, lift, drag, and weight as shown in Fig 1. Thrust is generated by the engine. The thrust is the force that moves the aircraft forward and helps provide the speed in order to generate lift. Lift is the force that pushes the aircraft upwards, and the lift is generated by the airfoil as the cross-section of the wing. Drag is generated by the aircraft's interactions with the air, according to Newton's 3rd law, and it is a force in the opposite direction of the velocity of the aircraft. Weight is generated by the materials that the aircraft is manufactured from, the fuel, the crew, and the payload in the aircraft. The weight force pulls the aircraft towards the ground. The lift has to be greater than the weight in order for an aircraft to take off. The lift has to be equal to the weight to have a steady or cruise flight (**NASA**).
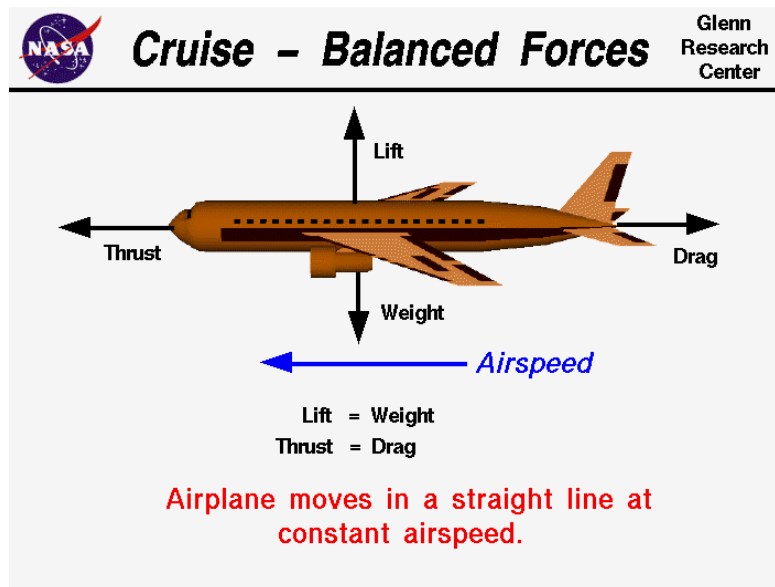
Fig 1 Applied Forces on Aircraft (**NASA**)

The Wright brothers used a flat airfoil first, but then they discovered that the curved airfoil could generate more lift. Based on the Wright brothers' discovery, the curvature allows the air on the upper surface to flow faster than the air on the lower surface. According to Bernoulli's principle, when the speed of the air increases, the pressure decreases, and vice versa. This means that the pressure on top of the airfoil is lower than the pressure below the airfoil, which generates lift upwards. The airfoil is shaped so that the upper surface of the airfoil has more curvature than the lower surface. As shown in Fig 2, the speed of the upper streamline is faster than the lower

streamline due to the curvature. That makes the upper pressure less than the lower pressure and the lift is then generated from the difference in the pressure (**NASA**).
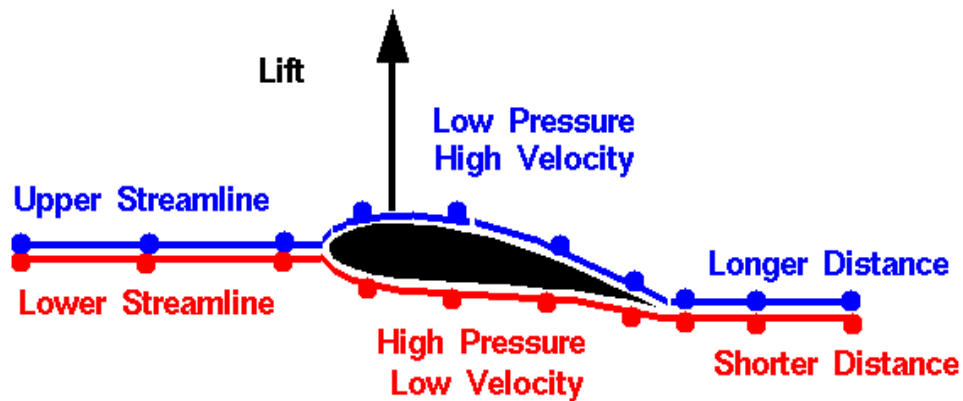
Fig 2 Flow around an airfoil (**NASA**)

The airfoil has two ends: the leading edge, and the trailing edge. The leading edge is a part of a circle, while the trailing edge is an angle. The chord line is an imaginary line from the trailing edge and leading edge. The camber is the asymmetry between the upper and lower surfaces of the airfoil. The thickness is the average between the upper surface and the lower surface. The angle between the relative wind and the chord line is called the angle of attack as shown in Fig 3. Increasing the angle of attack increases the lift generated by the airfoil until the stall is reached. Then, vortices form on the upper surface of the airfoil and decrease the lift significantly, as shown in Fig 4. After some research and development, aircraft engineers started to develop standard forms for airfoils (**NASA**)(**Wikipedia**).
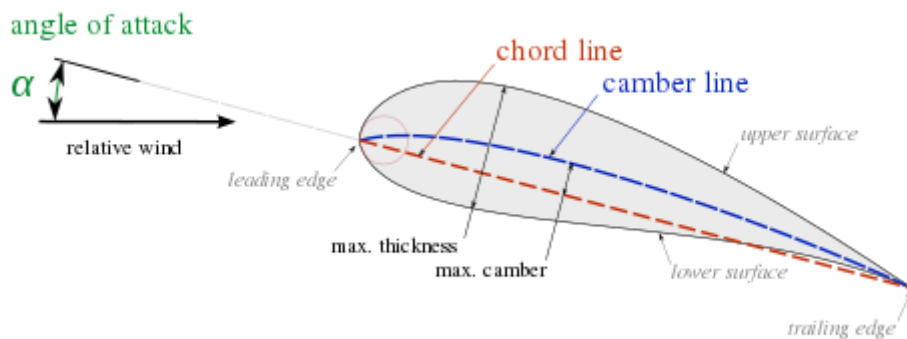
Fig 3 Angle of attack (**NASA**)
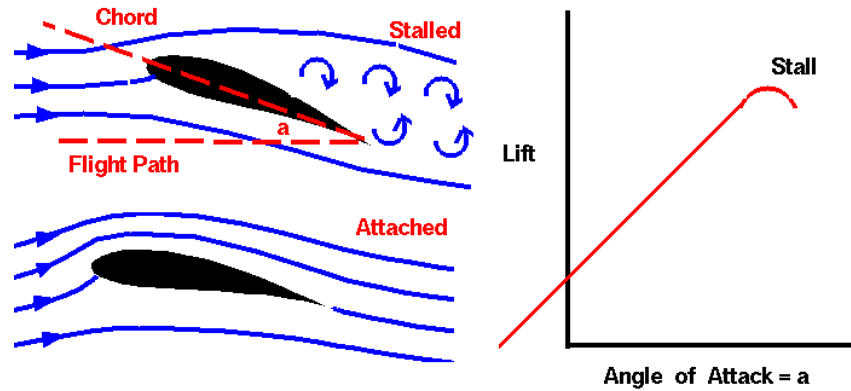
Fig 4 Aircraft Stall (**NASA)**

While engineers came up with standard forms for airfoils, NACA invested money to investigate how the airfoil shapes affect the lift and drag of the airfoil. NASA also built wind tunnels to test their airfoils at different airspeeds, to find out their lift and drag, as shown in Fig 5. NASA came up with an airfoil nomenclature. One example is NASA 4 digit which contains information about their maximum camber, the location of the maximum camber, and the maximum thickness. An example of this is shown in Fig 6. This data helps itemize different airfoils. NASA documented their tests in a report called the Summary of Airfoil Data, NASA documented the lift and drag of the tested airfoils. NASA's results of airfoil NACA 63(420) are shown in Fig 7.

Fig 5 NACA 4-digit airfoils (**NASA)**
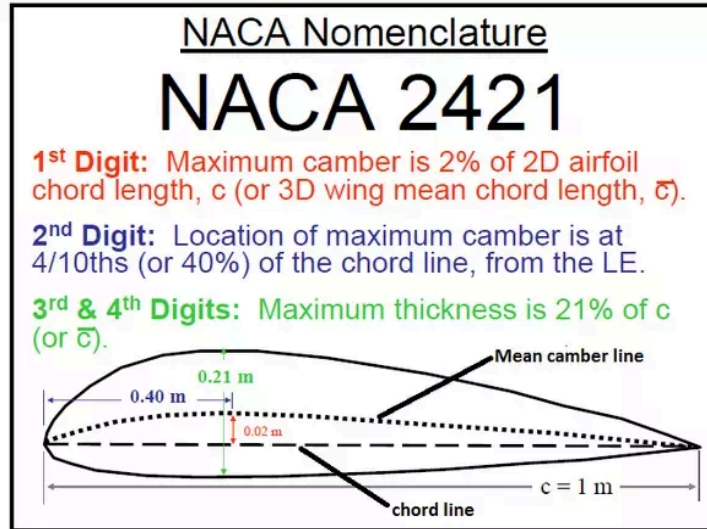
Fig 6 NACA wind tunnels (**Quora**)
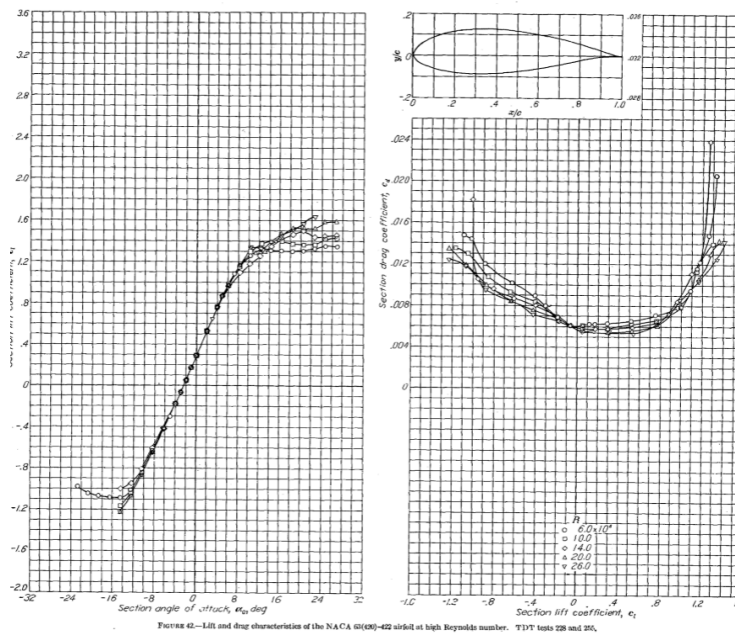
Fig 7 NASA summary of airfoil data (**NASA**)

In conclusion, the lift distribution and drag are affected by the airfoil shape. NASA tested airfoils and came up with the Summary of Airfoil Data that enabled engineers to create aircraft.

Works Cited

"Airfoil." *Wikipedia*, Wikimedia Foundation, 17 Mar. 2024, en.wikipedia.org/wiki/Airfoil.

"Airplane Cruise - Balanced Forces." *NASA*, NASA, 20 July 2023,
www1.grc.nasa.gov/beginners-guide-to-aeronautics/airplane-cruise-balanced-forces/.

"Equal Transit Theory Interactive." *NASA*, NASA,
www.grc.nasa.gov/www/k-12/airplane/cruise.html. Accessed 29 Mar. 2024.

"Fluid Dynamics Interactive." *NASA*, NASA, 14 Sept. 2023,
www1.grc.nasa.gov/beginners-guide-to-aeronautics/foilinc/.

"In a NACA 2415 Airfoil, What Do 0.02 Camber, 0.04 Chord, and 0.15 Thickness Mean?"
Quora,
www.quora.com/In-a-NACA-2415-airfoil-what-do-0-02-camber-0-04-chord-and-0-15-thi
ckness-mean. Accessed 29 Mar. 2024.

National Advisory Committee for Aeronautics,
ntrs.nasa.gov/api/citations/19930090976/downloads/19930090976.pdf. Accessed 29 Mar.
2024.

Parts of an Airplane, Grades 9-12,
www.nasa.gov/wp-content/uploads/2023/06/parts-of-an-airplane-9-12.pdf. Accessed 29
Mar. 2024.

"What Are Wind Tunnels? (Grades K-4)." *NASA*, NASA, 8 Feb. 2024,
www.nasa.gov/audience/forstudents/k-4/stories/nasa-knows/what-are-wind-tunnels-k4.ht
ml.

Transforming Informal Economies: An Analysis of the Impact of Microloans in Rio de Janeiro By Beatriz Rezende[5] and Cristiano Vinícius[6]

Abstract

This literature review analyzes the impact of microcredit in Rio de Janeiro, highlighting its role in transforming informal economies. Focused on micro, small and medium-sized companies, the study examines the microfinancing mechanisms of *Finep* and BNDES in the state, highlighting initiatives such as *Viva Cred*, *Crediamigo* and *AgeRio's* oriented productive microcredit. When addressing economic informality in the metropolitan region, the research highlights microcredit as an effective tool in combating informality, offering flexible alternatives that encourage business formalization. The study concludes that microcredit, by providing accessible conditions, stimulates financial inclusion, contributing to sustainable economic growth and presents exemplary case studies, such as *Barbearia DH*, *Brincalalá* and *Cervejaria Complexo do Alemão*, demonstrating how microcredit has boosted the success of these ventures and contributed to local economic dynamics.

KEYWORDS: microcredit, informal economy, economic development, financial inclusion, Rio de Janeiro.

 Introduction

Microloans, also referred to as microcredit, have emerged as a vital tool in transforming informal economies, playing a crucial role in promoting economic development and financial inclusion for small-scale entrepreneurs. This literary review aims to analyze the impact of microcredit in the specific context of Rio de Janeiro, considering its economic and social peculiarities.

Microloans in Brazil, anchored in the granting of low-value loans, play a significant role in offering financial resources to small informal entrepreneurs and micro-enterprises. The Brazilian approach, following a minimalist trend, emphasizes assisted credit granting, with socioeconomic analysis carried out by credit agents. The study focuses on micro, small and medium-sized companies, defined in advance, and explores the microfinance mechanisms offered by *Finep* and *BNDES* in the State of Rio de Janeiro.

Table 1
Microfinance Penetration Rate – Brazil (2001) and Other Countries (1999)

COUNTRY	ESTIMATED MARKET SIZE	ACTIVE CLIENTS	PENETRATION RATE
BOLIVIA	232.353	379.117	163%

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NICARAGUA	116.375	84.285	72%
EL SALVADOR	136.311	93.808	69%
PARAGUAY	82.984	30.203	36%
PERU	618.288	185.431	30%
CHILE	307.832	82.825	27%
BRAZIL	7.875.570	158.654	2%

Source: table 1 in Neto, Mário. "IMPACTO EM RENDA DO MICROCRÉDITO: Uma Investigação Empírica Sobre Geração de Renda Do Crédito Popular Solidário (São Paulo Confia) No Município de São Paulo." ["INCOME IMPACT OF MICROCREDIT: An Empirical Investigation into Income Generation from Crédito Popular Solidário (São Paulo Confia) in the City of São Paulo"]. Fundação Getúlio Vargas – Escola de Administração de Empresas de São Paulo, August 2006, pp. 44. https://hdl.handle.net/10438/2499.

Microcredit in Rio de Janeiro is exemplified by initiatives such as *Viva Cred*, which originated in 1997, and the *Crediamigo* program, implemented in 2009. *AgeRio*, with its oriented productive microcredit, plays a fundamental role, offering financing to formal entrepreneurs and informal with reduced rates and specialized guidance.

The Brazilian financial system faces challenges in meeting the needs of micro and small businesses and self-employed workers. Microcredit, by offering more accessible conditions, encourages formalization, promotes financial inclusion and contributes to sustainable economic growth. Finally, this article presents exemplary case studies, such as *Barbearia DH*, the *Brincalalá* enterprise and *Cervejaria Complexo do Alemão*, highlighting how microcredit boosted the success of these entrepreneurs and contributed to local economic dynamics.

Microcredit

Microcredit can be defined as "the granting of low-value loans to small informal entrepreneurs and micro-enterprises without access to the traditional financial system, mainly because they are unable to offer real guarantees. It is a credit aimed at production – working capital and investment – and is granted using a specific methodology." (Alexandre 8)

The Brazilian approach to microloans is based on assisted credit granting, aiming to minimize bureaucracy as much as possible. Before granting credit, a socioeconomic analysis of the entrepreneur is carried out, in which the client's intention and capacity are assessed. This process is conducted by a credit agent, who travels to the location of productive activity. The agent assesses payment needs and conditions, in addition to monitoring the progress of the business over time. When microcredit is intended for a single individual, guarantees similar to

those in the traditional system are required, such as a guarantor or sale of assets. According to Maraysa Alexandre:

> The steps for granting credit with the solidarity guarantee are: requesting credit, which involves filling out registration forms, collecting documents and carrying out registration searches; an evaluation visit carried out by the credit agent in which he analyzes the need for credit and payment capacity, in addition to evaluating the affinity between the group's components; group meeting that is led by the credit agent and, at which the credit is consolidated, the loan conditions are detailed and the group member requests the amount of the credit, in addition, the name of the group is chosen and the coordinator is elected who you will be responsible for the single bill; disbursement, which is the release of money into the account of each component; credit monitoring in which the application of credit is verified. (39)

There are currently two ideological trends linked to the way customers are treated concerning microcredit. The first is called developmental and, as the name suggests, argues that microcredit should be used as an instrument to combat poverty, associated with other forms of support1 for small entrepreneurs. The second, known as minimalist, argues that microfinance institutions must respect sustainability, offering financial services, without the need to link the concession to prior training. In Brazil, the minimalist trend is followed (Alexandre 36-37).

According to Mário Neto:

> In Brazil, a differentiation was established between three credit services: microcredit, productive microcredit and productive and oriented microcredit. The first refers to credit for low-income populations. The second is small-value credit for productive activities. The third refers to credit for productive activities based on the personalized relationship between the microcredit institution and the entrepreneur, through credit agents. (25)

Methodology

The objects of this study will be micro, small and medium-sized enterprises, which will be defined under the Brazilian Micro and Small Business Support Service (*SEBRAE*), which defines them as:

    i.   Micro-enterprises: up to 19 employees;
    ii.   Small companies: from 20 to 99 employees;
    iii.   Medium-sized companies: from 100 to 499 employees.

In Brazil, there are two main bodies involved in financing micro, small and medium-sized enterprises: the Studies and Projects Financier (*Finep*) and the National Bank for Economic and Social Development (*BNDES*). This study will analyze the main microfinancing mechanisms of these two bodies within the State of Rio de Janeiro's limits.

Finep is a public company, linked to the Ministry of Science and Technology. It is characterized, more specifically, as a federal agency that promotes innovation and technological development, operating in all areas of the innovative process. It was created in 1967, to

institutionalize the Studies, Projects and Programs Financing Fund, established in 1965 (de Paula 76).

The National Bank for Economic and Social Development (*BNDES*) is a public company linked to the Ministry of Development, Industry and Foreign Trade. Founded in 1952, the bank is currently the main long-term financing instrument in Brazil.

In 2012, the *BNDES* Innovation credit line was established to increase competitiveness through investments in innovation incorporated into the business strategy, encompassing improvements in both products and procedures and marketing strategies. The bank provides advantageous financing conditions for small and medium-sized companies. Analytical research carried out by Ernani Filho and Fernando Puga (2006) concludes that financial support had a positive impact on companies that received financing from *BNDES*, compared to those that did not receive support, during the period from 2001 to 2005. The analysis also indicated that financing contributed to the increase in jobs, being more significant in small companies financed.

BNDES also offers support for investments in micro, small and medium-sized companies through three products: BNDES Automatic, BNDES Card and Credit Limit. The first provides financing of up to R$20 million (US$ 5 million) for projects to implement, expand, modernize projects and even invest in Research and Development (R&D). The second is a pre-established revolving credit of up to R$1 million (US$ 200,000), intended to finance investments and acquisitions of approved products, including innovative services.

BNDES and *Finep* have some financing modalities for micro, small and medium-sized companies, including:

   i.   Refundable financing: loan of resources to support innovative activities in Brazilian companies, following Federal Government guidelines. The terms, rates and other financing conditions are defined following the Lines of Action established in the Operational Policy of the two institutions, and interest rate equalization may be used.

   ii. Non-refundable financing: can be granted to public institutions or private, non-profit organizations, to support scientific, technological and innovation projects. The economic subsidy modality consists of the application of non-refundable public resources, directly to companies, so that the costs and risks inherent to innovative activities are shared with them. It is an instrument widely used in developed countries (Finep).

   iii. Investment via Venture Capital: a form of financing that consists of participation, through the acquisition of shares or other financial instruments that do not require guarantees, in companies or ventures with great growth potential, in exchange for the prospect of a high return in the medium and long term. Due to their specificities, are the ones most suited to this instrument, especially innovative technology-based companies, which do not have access to the capital market or other traditional forms of financing, but offer high return prospects (Pinto 168).

Informality in Rio de Janeiro's Economy

Economic informality refers to the practice of economic activities that occur outside the limits and regulations established by the State. These activities are characterized by the absence of formal registration, formal employment contracts, payment of taxes and other legal obligations. In informality, transactions often occur directly between the parties involved, without the mediation of official institutions. Common examples of informality include street vendors, unregistered self-employed service providers and informal workers.

The presence of informality results from the growth of modern activities, which present a greater supply of work than demand, as evidenced by the scarcity of opportunities in rural areas and the so-called microelectronic revolution, which incorporated technical advances into modern activities. The heterogeneity of work activities is one of the central characteristics of informality. In addition to workers without a work permit and/or formal employment contract, the informal economy includes self-employed labor (or self-employed workers) and small employers. The latter engage in a variety of occupations, such as musicians, seamstresses, shoemakers, mechanics, hairdressers, private tutors, and others. The Metropolitan Region of Rio de Janeiro is an eloquent example of this phenomenon of informality (Guerra 19-44).

The history of informality in Rio's economy dates back to historical periods in which accelerated urbanization and industrialization coexisted with precarious working conditions. Since the beginning of the 20th century, Rio de Janeiro, as Brazil's economic and cultural center, has attracted a heterogeneous population in search of opportunities. Population growth and rapid urbanization created a context conducive to the emergence of informality, as many newly arrived individuals were compelled to seek means of subsistence outside the traditional structures of the formal labor market (Guerra 19-44).

In the scenario of those employed without a formal contract, a younger layer stands out, motivated by various reasons, such as a lack of experience in the profession and completing internships, for example. The probability of obtaining a job and the career earnings prospects of an incomplete university student who works as an intern in a large company differ significantly from the professional opportunities and expectations of a worker in small commercial establishments or in the service sector. This distinction represents a categorization within the scope of segmentation.

In this context, the Metropolitan Region of Rio de Janeiro assumes a self-employed profile, where income is not uniform among those without a formal contract and the self-employed. The income of the unregistered worker may depend on their productivity or union interventions, while the self-employed worker is subject to the characteristics of their business and the income of their clients. According to Brazilian Institute of Geography and Statistics (*IBGE*) data, more than 20% of workers point to restrictions on the formal market as a significant factor in entering the informal economy. This data contrasts the exclusion paradigm, indicating that entry into the informal market occurs due to the lack of opportunities in the formal sector. Table 2

Owners of informal sector companies, by gender, according to the reason that led them to start the business – 2003

Reason	%	Male	%	Female	%	Total
Could not find another job	22.43	150,149	7.36	49,278	29.79	199,427
Flexible hours	1.46	9,767	1.98	13,274	3.44	23,041
Independency	14.64	97,994	5.32	35,612	19.96	133,606
Family tradition	6.63	44,375	1.43	9,578	8.06	53,953
Supplementary income	7.85	52,577	11.69	78,311	19.55	130,888
Experience in the area	6.72	44,973	0.88	5,874	7.60	50,847
Promising business	4.55	30,494	1.05	7,014	5.60	37,508
Other reasons	2.93	19,585	3.08	20,618	6.01	40,203
Total	**67.21**	**449,914**	**32.79**	**219,559**	**100.00**	**669,473**

Source: table 3.5 in Guerra, Carlos. "Informalidade na Região Metropolitana do Rio de Janeiro a partir de 1990." ["Informality in the Metropolitan Region of Rio de Janeiro since 1990"]. Universidade do Estado do Rio de Janeiro, October 2009, pp. 80, http://www.bdtd.uerj.br/handle/1/7571.

Microloans in Rio de Janeiro: *Viva Cred*, *Crediamigo* and *AgeRio*

The offer of microcredit emerged in the city of Rio de Janeiro in 1997 with the institution *Viva Cred*. *Viva Cred* originated from an initiative by *Viva Rio*, an NGO established in Rio de Janeiro in 1993 in response to a crisis in the city that focused its efforts on members of the city's communities. Using the individual credit methodology, *Viva Cred's* operations were initially restricted to the *Rocinha Favela* community, later expanding to other locations. Today, in addition to the headquarters in *Rocinha*, there are units present in the community of *Rio das Pedras*, *Maré*, *Glória* - in the West Zone - and a unit in the interior of the State, located in the city *Macaé*.

When providing individual credit, the institution stipulates that the business has been operating for at least six months. The amount of credit, intended for working capital or fixed assets, varies from R$300.00 (US$60.00) to R$15,000.00 (US$3,000). The term for loans can reach twelve months, if the destination is working capital, and up to twenty-four months, if it is for fixed capital. The interest rate is 3.9%, with a credit opening fee between 2% and 5%. The

guarantee required to obtain the loan is the presentation of a guarantor, although this requirement is waived for customers with a positive credit history (Alexandre 36).

Microcredit operations at the institution have an average value of R$1,802.00 (US$360.40), with an average term of ten months. At the end of 2008, the institution's portfolio balance was R$4,437,766 (US$887,553.20), made up of 3,407 clients. The default rate was around 4%, and microcredit operations represented a loss of 1.89% of the capital invested in the institution (Alexandre 37).

As of February 2009, *Viva Cred* began implementing the *Crediamigo* program in Rio de Janeiro. *Crediamigo* considerably increases the chance of reaching a significant portion of this audience, due to lower interest rates, a more substantial financial volume and the managerial skill of a program that is recognized not only in Brazil, but also in Latin America. In addition to these positive aspects, the partnership brought a great boost to *Viva Cred* by enabling the offer of microcredit through the solidarity credit methodology.

Through the partnership, *Viva Cred* expanded its range of products, adopted more affordable rates and began requiring customers to have a bank account to receive credit. Other changes included the implementation of a more detailed analysis, which may result in a longer credit processing, and the obligation of a guarantor or joint guarantee in all cases of granting, even for customers with a favorable credit history, something which was previously not required in these cases. In addition, the organization implemented several changes, including a more in-depth selection process, a more structured training program, a more rigorous collection approach and a more active presence of credit agents in the field, promoting activities such as joint efforts and lectures.

AgeRio's oriented productive microcredit offers financing to formal and informal entrepreneurs at reduced interest rates, with the guidance of competent professionals. In collaboration with *SEBRAE*, the program also provides financial education. The agency, through its credit agents, analyzes the entrepreneur's business, assessing the need for credit, payment capacity and income generation capacity. After formalizing the contract, the agency monitors the appropriate use of the productive investment. The proximity of credit agents to low-income microentrepreneurs was fundamental to achieving the success stories that will be presented and analyzed later.

Microloans in the Fight against Informality in Rio de Janeiro

At this point, it is not an exaggeration to say that the Brazilian financial system is deficient in meeting the needs of micro and small companies, in addition to not being effective for self-employed workers. The main challenge for small business owners when seeking resources is the lack of guarantees, a barrier that financial institutions face when trying to reduce the risk of operations. This is due to the scarcity of reliable information about businesses and the difficulty for banks to assess risks without solid guarantees.

The banking sector does not support investments and is reluctant to share business risks. Thus, the informal sector lacks investments, and when they occur, they are predominantly financed with their resources. Although banks play a crucial role in the economy by providing

credit, taking deposits and offering a variety of services, the lack of support for the small business sector limits their impact on economic development.

In the Brazilian context, especially for those seeking small loans, the financial system is structured based on public sector financing needs and high credit risks. Banks lend to a few, applying high spreads and concentrating their operations on a limited group of customers, avoiding a significant expansion of the volume of credit.

The relationship between businesspeople and banks is generally punctual, localized and short-term. Banks rarely finance investments, and when they do, they impose requirements that make resources more expensive. This ends up compromising the capitalization of businesses, resulting in a limited contribution from the Brazilian banking system to financing new ventures. The lack of risk sharing between banks and entrepreneurs leads to a significant drain on the profits of companies that depend on banks for their business. In this scenario, the demand for credit is naturally low, as borrowers prefer to rely on their capital to manage their activities, aware that access to bank financing can compromise the health of their businesses.

Thus, it is concluded that microcredit, by offering more accessible and flexible conditions, encourages formalization by providing attractive financial alternatives. This not only drives financial inclusion but also creates an enabling environment for sustainable economic growth. Encouraging the expansion of small businesses boosts the demand for formalized labor, reducing unemployment rates and boosting local economic dynamics.

There are three interesting examples of the role of microcredit in combating informality in Rio de Janeiro – all driven by the previously analyzed *AgeRio's* guided productive microcredit. They are: *Barbearia DH*, *Brincalalá* and *Cervejaria Complexo do Alemão*.

In 2020, Horácio Silva de Mattos was one of the entrepreneurs who benefited from a R$5,000 (US$1,000) microloan. He is the owner of *DH Barbearia*, a beauty salon active since 2013 in the *Rocinha Favela*. *Rocinha* is the largest favela in Brazil, located in the South Zone of Rio de Janeiro and home to approximately 70 thousand inhabitants. The emergence of *Rocinha* dates back to the subdivision of farms on the old *Fazenda Quebra-Cangalha* farm, giving rise to a community characterized by socioeconomic disparities and facing significant infrastructure challenges. The venture represents the realization of an old dream for Horácio, who started saving money to make his idea a reality. Using microcredit resources, he was able to renovate the space, replace the stock and face the expenses arising from the period of social isolation (AgeRio, "DH Barbearia").

Intending to contribute to the education of children aged between one and five years old, Samara Teixeira innovated the proposal for her enterprise, *Brincalalá*. The design aims to reinvent the experience of traditional children's parties, incorporating elements such as music, storytelling, visual arts and activities that promote psychomotor development. To make this initiative viable, the entrepreneur turned to *AgeRio* and obtained financing of R$15,000 (US$3,000). This amount was directed towards the acquisition of toys and essential materials for recreation, holding an average of eight parties per month in the cities of *Niterói* and Rio de

Janeiro. Samara was recognized as one of the winners of the 2015 Brazilian Entrepreneur Award, in the Creative Business category (AgeRio, "Brincalalá").

Finally, Marcelo Ramos and Gabriel Romualdo, son-in-law and father-in-law, respectively, began their business journey by establishing a craft beer bistro in their garage. The proposal to obtain credit to improve and transform the space was presented to *AgeRio* by the entrepreneurs. The bistro, known as *Estação R&R*, achieved success in the *Complexo do Alemão Favela* region. *Complexo do Alemão*, located in the North Zone of Rio de Janeiro, is one of the city's newest neighborhoods. Its creation, in 1993, resulted from the promulgation of law nº 2055. With a population of approximately 180 thousand inhabitants, the neighborhood is made up of the favela communities of *Nova Brasília*, *Reservatório*, *Alvorada*, *Morro das Palmeiras*, *Casinhas*, *Fazendinha*, *Canitá*, *Pedra do Sapo*, *Mineiros*, *Morro do Adeus*, *Morro da Baiana*, *Matinha*, *Grota* (also known as *Joaquim Queiroz*) and *Morro do Alemão*

By expanding its portfolio to more than 300 national and international brands, the bistro attracted both the local public and visitors from outside the community. With the financial support provided by *AgeRio*, including credits for working capital and fixed investment, the entrepreneurs decided to launch their brand, called *Complexo do Alemão*. In 2015, the bistro achieved a weekly revenue of 7.3 Brazilian minimum wages (around US$2,061). The introduction of their line of craft beer earned them recognition, winning the "Successful Business" award in the same year (AgeRio, "Cervejaria Complexo do Alemão").

Conclusion

In summary, one of the main findings of this study is that microloans, by offering more accessible and flexible conditions, present themselves as an effective instrument in combating informality. The challenges faced by small business owners and self-employed workers when seeking resources from the conventional financial system, characterized by a lack of guarantees and a reluctance to share risks, are alleviated by microcredit. By providing attractive financial alternatives, microcredit not only boosts financial inclusion, but also creates an enabling environment for sustainable economic growth.

In the Brazilian context, marked by deficiencies in meeting the needs of micro and small companies, microcredit emerges as an essential catalyst for the development of the informal sector. Investments in the informal sector often depend on their resources, given the lack of support from the banking sector, which is reluctant to share business risks. This dynamic results in a limited contribution from the banking system to financing new ventures, which, in turn, negatively impacts the expansion of small businesses.

The specific cases presented vividly illustrate the positive impacts of microcredit on the lives of entrepreneurs and the economic dynamics of communities. These examples not only highlight the diversity of sectors benefiting from microcredit, but also highlight the importance of financial support in realizing dreams and consolidating successful ventures.

All of the analysis point to the continued importance of microcredit as a transformative agent in informal economies. Financial inclusion, encouraging entrepreneurship, generating formal jobs and boosting local economic development are interconnected aspects that reinforce

the relevance of microcredit as a powerful tool in the search for more inclusive and sustainable societies. Moving forward, continued collaboration between financial institutions, governments and non-governmental organizations is essential to expand and enhance microcredit programs, thereby driving the positive transformation of informal economies around the world.

Works Cited

AgeRio. "Brincalalá." *AgeRio - Brincalalá*, 8 Sept. 2021,
    www.agerio.com.br/casos-de-sucesso/brincalala/#%3E.

AgeRio. "Cervejaria Complexo do Alemão." *AgeRio - Cervejaria Complexo Do Alemão*,
    21 Jan. 2020,
    www.agerio.com.br/casos-de-sucesso/cervejaria-complexo-do-alemao/#%3E.

AgeRio. "DH Barbearia." *AgeRio - DH Barbearia*, 20 July 2023,
    www.agerio.com.br/casos-de-sucesso/dh-barbearia/#%3E.

Alexandre, Maraysa. "Histórico do Microcrédito no Brasil, com Foco na Cidade do Rio
    de Janeiro: Surgimento, Evolução e Tendência." ["History of Microcredit in
    Brazil, with a Focus on the City of Rio de Janeiro: Emergence, Evolution and
    Trend"]. *Pontifícia Universidade Católica do Rio de Janeiro*, December 2010, pp.
    8; 36-37; 39.
    https://www.econ.puc-rio.br/uploads/adm/trabalhos/files/Maraysa_Ribeiro_Alexa
    ndre.pdf. Accessed 16 Jan. 2024.

de Paula, Gabriela. "Mecanismos de Financiamento à Inovação para Micro, Pequenas e
    Médias Empresas no Brasil." ["Financing mechanisms for innovation for micro,
    small and medium-sized companies in Brazil"]. *Pontifícia Universidade Católica
    do Rio de Janeiro*, April 2015, pp. 76.
    https://sucupira.capes.gov.br/sucupira/public/consultas/coleta/trabalhoConclusao/
    viewTrabalhoConclusao.jsf?popup=true&id_trabalho=2373666. Accessed 12
    Dec. 2023.

Guerra, Carlos. "Informalidade na Região Metropolitana do Rio de Janeiro a partir de
    1990." ["Informality in the Metropolitan Region of Rio de Janeiro since 1990"].
    Universidade do Estado do Rio de Janeiro, October 2009, pp. 19-44; 80,
    http://www.bdtd.uerj.br/handle/1/7571. Accessed 11 Jan. 2024.

Neto, Mário. "IMPACTO EM RENDA DO MICROCRÉDITO: Uma Investigação
    Empírica Sobre Geração de Renda Do Crédito Popular Solidário (São Paulo
    Confia) No Município de São Paulo." ["INCOME IMPACT OF MICROCREDIT:
    An Empirical Investigation into Income Generation from Crédito Popular
    Solidário (São Paulo Confia) in the City of São Paulo"]. *Fundação Getúlio Vargas
    – Escola de Administração de Empresas de São Paulo*, August 2006, pp. 25; 44.
    https://hdl.handle.net/10438/2499. Accessed 14 Dec. 2023.

Pinto, Luciane. "Capital de Risco: Uma Alternativa de Financiamento às Pequenas e
    Médias Empresas de Base Tecnológica – O Caso do Contec." ["Venture capital: A
    financing alternative for small and medium-sized technology-based companies –
    The case of Contec"]. *Revista do BNDES*, vol. 4, no. 7, June 1997, pp. 168.
    http://web.bndes.gov.br/bib/jspui/handle/1408/11176. Accessed 22 Jan. 2024.

Finep. "Subvenção Econômica para Inovação." *Finep*, 2018,

Personalized Medicine: Mitigating Adverse Drug Reactions and Revolutionizing Healthcare By Aadarsh Senthil

Imagine a world in which medications transcend the one-size-fits-all approach of the twentieth century and are custom-tailored toward patients on a genetic level. Individuals would stop suffering from the side effects of ineffective medications and avoid repeated trips to the hospital. This would not only relieve the workers in the healthcare system but lift the economic burden that it imposes on healthcare companies and customers. That world will soon be a reality, and personalized medicine is the answer. In the present day, healthcare is often centered around polypharmacy—the use of five or more medications regularly—and patients are sometimes nothing more than a doctor's test subject, experimenting with medications until they find the right fit. The consequences of this, however, are immense and result in what are known as adverse drug reactions (ADRs). An adverse drug reaction is an unintended and harmful response to a drug that takes place at normal doses, and it often leads to unnecessary hospitalizations (*Adverse Drug* 1). The fact that these unexpected reactions cost the healthcare system $528 billion annually and are the fourth leading cause of death in the US poses a massive problem (Rubinstein). Personalized medicine stands as the solution to reducing adverse drug reactions and the burden on the healthcare system, specifically by avoiding the traditional trial-and-error approach and shifting the attention from reaction to prevention. Furthermore, it has already been proven to be an effective measure of decreasing ADRs. However, to make this a reality, there needs to be more extensive databases and a translational research framework.

First and foremost, a proper definition and background on ADRs is required to understand their effect on the healthcare system. As mentioned before, adverse drug reactions are "response[s] to a drug which is noxious and unintended and which occurs at doses normally used in man" (*Adverse Drug* 1). Oftentimes, ADRs are mistaken for side effects, and the failure to distinguish between the two can lead to severe consequences. While side effects are expected, and are a measure of the body's immune response, ADRs are unexpected, and a sign that the drug is causing more harm than benefit. With proper awareness and care, adverse drug reactions can be prevented before they cause harm, and these "medication errors that are stopped before harm…are called…potential adverse drug event[s]" (*Adverse Drug* 3). Due to the unforeseen nature of ADRs and ADEs, hospitals and healthcare workers are forced to track every one of these cases, along with the symptoms that result, in an attempt to prevent them from happening to other individuals.

On a larger scale, however, adverse drug reactions have a larger impact on the healthcare system than just requiring tracking of cases. With an increased number of unnecessary hospitalizations that are drug-induced, healthcare workers are struggling to care for patients, insurance companies are struggling to keep up with rising hospital costs for their customers, and in turn, customers are struggling to keep up with rising premiums, resulting in an unsustainable cycle for the healthcare system. To put this into perspective "the cost per patient of preventable ADRs was measurable in thousands of dollars, associated with a considerably increased length of

hospital stays" (Micaglio et al.). A study that was done in an Ethiopian hospital regarding ADRs found statistically significant data, showing that:

> The length of hospital stay was much longer in patients with ADRs than without ADRs (19.8 vs 15.2 days) … ICU visits (11.2% vs 6.8%) and in-hospital mortality (4.4% vs 1.9%) were significantly higher in patients with ADRs compared with those without ADRs, [and that the patients with ADRs] were significantly charged with higher direct medical costs compared with those without ADRs (6237.2 vs 5256.3 Ethiopian birrs). (Sendekie et al.)

In addition to the economic impact, there is something even more valuable at stake—human lives. This is the fourth leading cause of death in the US, and "according to a meta-analysis published in 1998, more than 100,000 patients die yearly in the US because of ADRs" (Micaglio et al.). It is evident that awareness needs to increase regarding ADRs, and a solution is desperately needed.

Personalized medicine is the polar opposite of polypharmacy. It is a type of patient care that customizes treatments for every individual, specifically based on their genetic makeup. This relatively new field originated some 25 years ago, when scientists started the search for evidence-based medicine, rather than the uniform medicine every patient was receiving at the time. Relying on the central dogma, researchers looked to investigate DNA composition to make progress, especially since "it's estimated that 99.9% of the human genome is identical in all people; only 0.1% of our DNA accounts for individual differences, including variations in drug metabolism and increased disease risk" (Kudzma and Carey 51). There were no advances in personalized medicine until the Human Genome Project was completed in 2003. This project, which was started in 1990, looked at every single base pair that the human genome contained and sequenced all of the genes. Science journalist Dr. Fred Schwaller writes that "the Human Genome Project was perhaps one of the most important steps towards personalized medicine" (Schwaller 3), as it allowed scientists to hone in on the 0.1% of DNA that differs between humans and observe the mutations that take place. Researchers found that there is one specific group of enzymes that are responsible for "metaboliz[ing] and break[ing] down more than 30 classes of drugs, or roughly 60% of common prescription drugs" (Kudzma and Carey 51). This group of enzymes is known as the Cytochrome P-450 enzymes and is controlled by the CYP genes. Mutations in the three most important CYP genes—CYP2D6, CYP2C19, and CYP2C9—can result in drug metabolism deficiencies. These discoveries led to many researchers flocking to this new area, resulting in "a well-differentiated subspecialty of clinical genetics called 'pharmacogenetics,' defined as 'the study of how variations in a few genes affect the response to medications" (Micaglio et al.). Pharmacogenetics is the main component behind personalized medicine and acts as a bridge between the patient's biological composition and the required medication prescription. This is because "the main role of pharmacogenetics is to translate genetic information into everyday medical practice, trying to lower the impact of

ADRs, both for patients and for the healthcare system" (Micaglio et al.). Through pharmacogenetics, patients are prescribed a singular medication based on their genetics, therefore leading to significantly lower chances of an adverse drug reaction taking place and reducing the cycle of destruction that the modern-day healthcare system faces.

One of the main advantages that personalized medicine possesses over the present-day medicinal care system is that it avoids the trial-and-error approach. With many people nowadays taking prescription medications to relieve them of their ailments, hundreds, if not thousands of drugs have hit the market, leaving patients and doctors with a multitude of options. The presence of these options leads doctors to keep prescribing medications until a patient finds the right match. This is known as the trial-and-error approach and can lead to several negative symptoms and ADRs. In fact, "studies show that 2 out of 3 individuals fail the first medication they are prescribed, and spend weeks, months or years cycling through multiple drugs that either don't provide adequate relief of symptoms, cause side effects, or both" (Siminovitch). The trial-and-error approach originated in the twentieth century when Big Pharma developed, and was appropriate at the time to deal with the sudden influx of prescription drugs in the healthcare system. However, times have changed, and the twenty-first century has brought about advancements in technology and the capability to do a lot better. The trial-and-error approach for medication is outdated, and one of the main reasons this approach to prescribing medication "often fails is [because] every individual is unique in how they will respond to different drugs, based on their genetics" (Siminovitch).

More specifically, for psychiatric medications such as antidepressants or antipsychotics, this approach has proven to be significantly worse. Take, for example, Susan, a nurse from Alberta, Canada. She cycled through countless antidepressants for fifteen years and still did not find the right medication for her. Only after she took a pharmacogenetics test did she find the right fit, and is now "taking a medication compatible with her genes, and has been able to return to work and regain her quality of life" (Siminovitch). Over the course of those fifteen years, not only did she fail to treat her depression, but she also gained many other disabilities as a result of the many different medications she took. On top of all of this, her economic situation was also being affected by all the various prescriptions that she was buying. Susan was able to end many years of struggle (which was caused by the trial-and-error approach) with a simple test, saving time and money. Doctors and their patients need to stop taking shots in the dark and utilize pharmacogenetic testing and personalized medicine to prevent the trial-and-error approach.

Another significant advantage that personalized medicine brings to the table is regarding the approach to medicine itself. Traditionally, medicine has been used as a way to respond to any unfortunate problems that occur, whether it be sickness, disease, injury, etc. Most patients do not visit the doctor if they think that they are going to get sick; they visit the doctor if they really are sick, or if they were injured doing something. Therefore, medicine has mostly been reactive, acting upon a certain injury or event that took place. However, this focus on reactive medicine rather than preventative medicine puts a lot of stress on hospitals and healthcare workers. Instead of increasing the number of doctors and nurses and beefing up the medical personnel, another

approach is to reduce the number of people getting sick and having these injuries through preventative measures. The healthcare system has already started to do this, and one main example is the development of vaccines. The flu vaccine has been around for many years now and reduces the number of people getting sick, so the healthcare system has to deal with fewer cases. Another prime example of this was during the COVID-19 pandemic. In the beginning, the response was purely reactive medicine, but as more research was performed and a vaccine was developed, preventative medicine was enforced. Nowadays, the presence of the COVID-19 vaccine and preventative medicine is the sole reason that the virus is under control and life has returned to normal.

Similarly, personalized medicine can shift the attention in medicine from reaction to prevention, primarily through two main ways. Principally, personalized medicine paves the way for the diagnosis of diseases and reveals genetic predispositions. Pharmacogenetic testing "introduces the ability to use molecular markers that signal the risk of disease or its presence before clinical signs and symptoms appear," and as a result of this, doctors can employ a "healthcare strategy focused on prevention and early intervention rather than reaction to advanced stages of disease" (Abrahams and Silver), effectively reducing the severity of symptoms and the risk that is present. For instance, genetic testing can reveal whether there is a harmful mutation in the BRCA1 and BRCA2 genes. These two genes are known as tumor suppressor genes, and when they don't function normally, can lead to breast cancer. Since this risk is inherited, only a genetic test would reveal this potential danger. Early diagnosis would then permit doctors to take preventative steps such as increased screenings, lifestyle modifications, and surgery if necessary. Another way that pharmacogenetics and personalized medicine shift the focus away from reactive measures is by enabling individualized prevention strategies. As it avoids the traditional trial-and-error approach, it is much more efficient, and "allows the physician to select an optimal therapy the first time" (Abrahams and Silver) rather than using a multitude of prescriptions. Furthermore, "getting to the right drug sooner can lead to improved health for the patient or, in the case of deadly conditions, a better chance of survival" (Abrahams and Silver). Now that the treatment is taking place at the early stages of the disease, it becomes a preventative measure rather than a reactive one, shifting the focus yet again. With the increased use of genetic testing and personalized medicine, the transformation to a healthcare system revolving around preventative medicine is possible in the future.

Personalized medicine has already proven to be an effective method to reduce adverse drug reactions in multiple experiments and cases around the world, resulting in many success stories. Similar to Susan from Alberta, Kristen Davis is another individual who suffered from depression throughout her teenage and college years, also having suicidal ideations frequently. Initially, the antidepressants that she was taking seemed to work for her, and she was cured of her depressive episodes, completing her undergraduate degree at Duke University. However, later in graduate school, she had a relapse, and the depressive and suicidal thoughts kept coming back to her. Her psychiatrist prescribed the same antidepressants as before, yet this time around, nothing seemed to work. She was having trouble sleeping at night, did not have an appetite, committed

self-inflicted harm, and was eventually admitted to a psych ward. Despite being prescribed over fifteen different combinations of psychiatric medications, there was still no success. As a last resort, she ended up at an alternative treatment center that was experimenting with genetic testing. After volunteering to take a test, the doctor prescribed her a completely different medication this time, and two weeks later, she was feeling better than ever ("Kristen Davis").

Another case study that was presented in *Connecticut Medicine* in 2007 saved a woman's life with the help of personalized medicine. The patient was "a 54-year-old woman presented with severe anxiety, multiple somatic complaints, medication intolerance, and adverse drug reactions to numerous prescribed psychotropic medications" (Ruaño et al.). Over the course of her treatment, doctors had prescribed over thirty different drugs, and the ADRs that she experienced resulted in her being bedridden and hospitalized in the ICU for a long period. With no other choice, scientists took her saliva sample and ran a test. Genetic testing found significant deficiencies in her drug metabolic capacity:

> Molecular analysis was performed for the CYP2 family of Cytochrome P450 (CYP450) drug metabolism isoenzymes by DNA typing CYP2D6, CYP2C9, and CYP2C19 genes. A multiple deficiency in CYP2 drug metabolism was discovered. The patient was a double carrier of null alleles for CYP2D6, a carrier of a null allele for CYP2C19 and a carrier of a deficient allele for CYP2C9. (Ruaño et al.)

Once she was slowly weaned off the existing drugs and given a drug that utilized a different genetic pathway, she returned to her normal, healthy state in a few months. Both of these case studies show the power of personalized medicine, and how it has already proven to be very effective and efficient. Furthermore, it has also shown its potential as a reactive treatment if necessary and can help individuals quickly recover from their sicknesses.

Despite the multiple advantages that personalized medicine presents to combatting ADRs and the effect they have on the healthcare system, there is a significant amount of work necessary to integrate pharmacogenetics and customized drug prescriptions into hospitals and healthcare centers all around the world. One of the main drawbacks at this moment is the lack of extensive databases. Personalized medicine is dependent upon a multitude of characteristics and approaches, with pharmacogenetics being a main component, and "tailored approaches based on multidisciplinary cumulative data (including genetic, biomedical, and behavioral measures) from experimental and observational databases…are insufficiently available" (Evers et al.). This is largely due to the lack of awareness, and the resulting lack of funding that is associated with research for personalized medicine. Without these databases, doctors and other caregivers are unable to pursue certain personalized treatment plans for their patients. Furthermore, without extensive databases, doctors will not know which drugs work with certain gene pathways. These databases provide a solid foundation and a level of confidence for doctors to make prescription decisions.

This leads to the other drawback of personalized medicine that requires development. For extensive databases to be built upon, researchers need a way to apply their findings and data to medicine and for human benefit. Formally known as a translational research framework, personalized medicine lacks the presence of this as well. This "coherent framework for science, care, and management has to be developed," allowing for the use of "tailored and individual based approaches…beyond traditional diagnostics and classification methods" (Evers et al.). Similar to the drug development process that is regulated by the Food and Drug Administration, which contains multiple phases like basic research, drug discovery, preclinical research, clinical research, and drug approval, the findings that researchers make regarding personalized medicine need to follow an official process before they are used by doctors. The lack of this framework is due to meager interest in personalized medicine, and the resistance to change in the healthcare system.

Finally, the last drawback that surrounds personalized medicine is the lack of awareness regarding its efficacy, mainly due to the lack of significant empirical evidence. Studies and experiments that show the "effectiveness of personalized medicine in comparison with more traditional models are still scarce in almost all disciplines" (Evers et al.) and must be developed by researchers. However, researchers are unable to contribute with studies and experiments because they require a translational research framework. Therefore, it is evident that the different developments that are still required to bring personalized medicine to the mainstream are all intertwined, and advancement will only take place by starting at the root of the problem. This would mean focusing on creating a robust framework that would permit personalized medicine to replace the drug development process. Nevertheless, all of these developments are significant ones that take years if not decades, and show that there is still a lot of work left before personalized medicine can be brought to every corner of the healthcare community.

Ultimately, even with challenges such as limited databases, the absence of a robust translational research framework, and the lack of awareness, personalized medicine emerges as the solution for diminishing the adverse drug reactions that take place in the modern healthcare system. Personalized medicine and pharmacogenetics can also significantly inhibit the economic and humanitarian impact that is currently present due to ADRs. The awareness regarding adverse drug reactions is very low, yet as the fourth leading cause of death in the US that claims hundreds of billions of dollars every year, these unexpected symptoms that arise as a result of the wrong prescription drugs have an immense impact on the healthcare system. Personalized medicine is the most effective way to combat this, and is powered by pharmacogenetics—the scientific field concerned with the application of clinical genetics in drug prescription, specifically looking at the CYP genes for drug metabolism. This unconventional approach has a variety of benefits, primarily since it avoids the trial-and-error approach, which is the main cause of ADRs and unnecessary hospitalizations. Furthermore, personalized medicine changes the perspective of healthcare as a whole, shifting the focus from reactive measures to proactive and preventative actions that work to make everyone healthier in general. Finally, personalized medicine has already proven to be effective, helping individuals at their lowest turn their lives

around by finding the correct drug, and reversing the damage inflicted by polypharmacy. There is still progress that needs to be made regarding the development of personalized medicine to make it suitable for widespread use. Extensive databases are necessary to provide doctors with a foundation for treatments, a translational research framework is necessary for researchers to help contribute to these databases, and awareness needs to be increased through empirical evidence, mainly through the form of studies and experiments. As the healthcare system continues to evolve, personalized medicine will emerge as a frontrunner, revolutionizing patient-centric care, and fostering an individualized approach based on genetic composition, bringing about a new era of medicine.

Works Cited

Abrahams, Edward, and Mike Silver. "The case for personalized medicine." *Journal of diabetes science and technology* vol. 3,4 680-4. 1 Jul. 2009, doi:10.1177/193229680900300411

Adverse Drug Events, Adverse Drug Reactions and Medication Errors. Veterans Affairs, https://www.pbm.va.gov/PBM/vacenterformedicationsafety/tools/AdverseDrugReaction.pdf.

Evers, Andrea W. M., et al. "An Integrated Framework of Personalized Medicine: From Individual Genomes to Participatory Health Care." *Croatian Medical Journal*, vol. 53, no. 4, Aug. 2012, pp. 301–03. *EBSCOhost*, https://doi.org/10.3325/cmj.2012.53.301.

"Kristen Davis: a pharmacogenomics success story." *Illumina*, 14 June 2022, https://www.illumina.com/content/dam/illumina-marketing/documents/icommunity/pgx-kristen-davis-story-m-gl-00722.pdf. Accessed 19 February 2024.

Kudzma, Elizabeth C., and Eileen T. Carey. "Pharmacogenomics: PERSONALIZING DRUG THERAPY: The Human Genome Project Is Revolutionizing Drug Prescribing." *The American Journal of Nursing*, vol. 109, no. 10, 2009, pp. 50–58. *JSTOR*, http://www.jstor.org/stable/27867392. Accessed 6 Dec. 2023.

Micaglio, E, ET Locat, MM Monasky, F Romani, F Heilbron, and C Pappone. "Role of Pharmacogenetics in Adverse Drug Reactions: An Update towards Personalized Medicine." *Front Pharmacol.* 2021 Apr 30;12:651720. doi: 10.3389/fphar.2021.651720. PMID: 33995067; PMCID: PMC8120428.

Ruaño, Gualberto et al. "Somatic complications of psychotropic medications in a patient with multiple CYP2 drug metabolism deficiencies." *Connecticut Medicine* vol. 71,4 (2007): 197-200.

Rubinstein, Carrie. "A Potential Solution For The 4th Cause Of Death In The U.S." *Forbes*, 14 November 2023, https://www.forbes.com/sites/carrierubinstein/2023/11/14/a-potential-solution-for-the-4th-cause-of-death-in-the-us/. Accessed 19 February 2024.

Schwaller, Fred. "How Personalized Medicine Is Transforming Healthcare." *Advances in Personalized Medicine*, e-book ed., Technology Networks, 2022, pp. 3-5. PDF.

Sendekie, AK, AE Kasahun, LW Limenh, AD Dagnaw, and EA Belachew. "Clinical and economic impact of adverse drug reactions in hospitalised patients: prospective matched nested case-control study in Ethiopia." *BMJ Open*. 2023 Jun 6;13(6):e073777. doi: 10.1136/bmjopen-2023-073777. PMID: 37280017; PMCID: PMC10255243.

Siminovitch, Katherine. "Eliminate the Trial and Error Approach in Finding the Right Medication." *Health Insight*, www.healthinsight.ca/managing-illnesses/eliminate-the-trial-and-error-approach-in-finding-the-right-medication/.

An Examination of the Legacy of the Down to the Countryside Movement By Melinda Liu

The "Up the Mountains and Down to the Countryside Movement," often shortened to "Down to the Countryside Movement," was a part of China's Cultural Revolution, an initiative to purge China of capitalist and traditional elements made by Chairman Mao Zedong that originated in the mid-1950s (Yang, Xu, *Dartmouth Library*, 2019) and mostly took place between 1966 and 1976 (You, *CNN*, 2012). As part of this Movement, China's urban youth were sent instead to China's impoverished countryside to learn from poor and middle-class peasant farmers (Ownby, Hui, *Reading the China Dream*). Chairman Mao also thought that the "future of China" depended upon "developments in the countryside", which he hoped that the Movement would aid (Yang, Xu, *Dartmouth Library*, 2019) In addition to helping to improve the countryside, the Cultural Revolution left many restless teenagers engaging in violent and dangerous activities, and it was hoped that this movement would help ease the tension (Wu, Fan, *Rozenburg Quarterly*). Nearly 17 million were sent down into the countryside between 1968 and 1978 (Xie, Ye, Sagraves, *Dartmouth Library*) - where they were "deprived of the chance of education and the right to live with their families" (You, *CNN*, 2012).

The Up the Mountains and Down to the Countryside Movement in China marked a negative turning point in the lives of the children who experienced it and China as a whole because they had to do intense and dangerous hard labor that left persisting physical ailments, a lack of job and government support opportunities after the Movement ended, and social scars left on Chinese society as a direct result of the Movement.

Hard physical labor that mostly involved farm work made up a large portion of the Movement. Weijian Shan, now the chairman of a large Chinese company, PAG, was sent to the Gobi Desert, "one of the harshest climates on Earth," in an attempt to establish and continue agriculture there. There were few resources when the unit arrived. In the Gobi, temperatures are unpredictable and change from one extreme to the other.. "Initially, they dug deep holes in the sand to sleep," until they could build shelters. The unit worked "[for] years and years under the blazing sun in the summertime and in the deep cold in the wintertime, day in and day out—12, 14, sometimes 18 hours a day—trying to transform [the Gobi Desert] into fertile farmland." Though the unit worked for many years, their labor rarely yielded any crops (Watson, *GPS News*, 2020). The labor that Shan endured was arduous, especially for untrained teenagers, given the harsh conditions in the Gobi, a lack of resources, and the extreme difficulty of the task that the unit was presented with. This led to formative years being spent working long hours on a near-impossible task that led to extreme physical discomfort. Needless to say, this was a glaringly negative experience in the lives of the children who experienced it.

Hu Rongfen, a sent-down youth from Shanghai sent to the Anhui Province, "still can't bear to recall [her] youth spent working on the farm." She remembers working in the rice fields in the cold months of early spring, where "chunks of ice still floated." Hu would "bend down and seed for more than ten hours" at a time. In another instance, Hu remembers "walking 40 kilometers along mud paths against bone-chilling winds to the nearest bus station" in order to

visit her parents in Shanghai. Hu says, "If the Cultural Revolution came back and I were to be dispatched again, I'd rather commit suicide" (You, *CNN*, 2012). It is clear that Hu views her time in Anhui as part of the Movement in a mostly negative light. It is easy to understand why, as she was separated from her family and did hard labor even in harsh conditions. An environment that involves routine separation from family and physical labor that teenagers are not adept for is clearly a negative one.

Another sent-down youth - teenagers who were relocated to the countryside - Huang remembers "the train and bus stations of Chinese cities filled with sobbing adolescents and frightened parents" on the day she left for the countryside. The Movement was not viewed in a largely negative light at first, despite the uprooting of the teenagers from their previous life in the city. "At the very beginning, we were all idealistic. We wanted to make a difference to the countryside," Huang says. However, the dirty, impoverished villages and hungry peasants were thoroughly unimpressed with the urban teen's grand dreams for improvement. Although some villagers were kind, most were openly hostile. Despite their education, most of the urban teenagers had no idea how to farm, or do labor that peasants could easily do. Because income was not given based on need, but instead on the amount of work, most teenagers found themselves struggling to find enough food or housing (Branigan, *The Guardian*, 2023).

Violence was rampant, especially sexual violence. City girls, separated from the protection of their families, were frequent targets of sexual violence. These incidents often went unreported, for fear of punishment, as the perpetrators were often higher-ranking officers. "A girl who did not receive her mother's last loving letter as she succumbed to her injuries after being raped," (Hille, *The Financial Times*, 2013) is just one of the countless victims of sexual abuse and assault, many of whom remain nameless and faceless to this day. Corruption and mistreatment by higher-ranking officers and untreated illness resulted in the deaths of many others. One of Huang's friends was imprisoned on suspicion of being anti-party and died in prison when he was just 14. Another friend succumbed to an illness that was dismissed as "just a cold." Countless others died of disease and hunger, having already been weakened from overwork and harsh conditions (Branigan, *The Guardian*, 2023). The amount of violence and corruption present during the Down to the Countryside Movement that came hand-in-hand with dangerous conditions and labor is astonishing. Any place or situation where untreated illness, sexual violence, and corruption are commonplace is almost certainly a negative one, especially when children are the victims.

In addition, not only did this labor have an effect on the children at that point in their lives, but physical ailments as a result of this labor persisted for years and decades after the end of the Movement. When Han Dehong, another individual sent to the countryside as a teenager, left Changsa in 1964, he was healthy, with no physical ailments. By the time he "returned home a decade later, his left eye had gone blind and he suffered from a series of ailments, including gastric ulcer and sporadic bouts of numbness." Han's hard work added to his extensive health issues, which came as a result of malnutrition and poor medical care in the countryside (Beng, *The Straits Times*, 2016).

Even after the Movement ended, these ailments, and other circumstances such as missing crucial years of education, prevented former sent-down youth from making the most of their freedom and working a higher-paying job that required a degree. Most former sent-down youth found themselves without work and a government pension. This was a negative consequence of the movement, especially because of the lasting impact left on the youth and limited future opportunities.

In 2016, one thousand people, all former sent-down youth, marched outside the Civil Affairs Bureau of Shanghai. The years spent outside of the city "left them far poorer in terms of social security and health care entitlements" and "they [were] still paid pension at a level appropriate to rural areas," which means they cannot support themselves in one of the world's most expensive cities. The *hukou* system in China is a system where citizens are given governmental aid based on a single registered house. Sent-down youths were being treated as if their *hukou* were still in the rural countryside. "We should be able to enjoy some security in our later years, and enjoy life at home," Zhang, one of the former sent-down youth protesters, puts it. "Why are we coming here in such cold weather? We have no other choice. We're not trying to create unrest; we are struggling to survive" (Ding, Mudie, *Radio Free Asia*, 2016). Han Dehong, another former sent-down youth, is also now "penniless" and "relying on his daughters and younger siblings to support him." He has tried "several times to apply for financial assistance from the local government bureaus but was rejected because his hukou was registered somewhere else" (Beng, *The Straits Times*, 2016).

After years of suffering in the countryside and physically and mentally taxing hard labor, the former sent-down youth, now in one of China's largest cities, are still, to this day, struggling to survive. The *hukou* system has widely been criticized for being biased toward certain socioeconomic groups, and this is clearly evident in how the system affects the formerly sent-down youth. The scars from the Down to the Countryside Movement were not just temporary but continued to bleed into the lives of the sent-down youth even years after. Decades after the end of the Movement, they still must march for and rely on family for the most basic of rights.

In addition to government support opportunities, jobs both now and directly after the end of the Movement are scarce for the former sent-down youth. After years of missed education, jobs were hard to find upon return to the cities. Younger more educated potential employees were emerging from the newly opened universities. The luckier sent-down youth had the family connections to go to university or secure a well-paying position. Most took up manual labor jobs that were not unlike the labor they had performed in the countryside—the most desperate resorted to prostitution or violent crime (Branigan, *The Guardian*, 2023). Cao Yifei, a sent-down youth originally from Shanghai, says, "What I regret most is that I didn't get an education. I could have gone to university if we hadn't been there." She was only able to get a job after her father retired, freeing up his job for her (Hille, *The Financial Times,* 2013). Weijian Shan, another former sent-down youth, believes that the greatest waste of the Down to the Countryside Movement was the human potential "because there was no education, so many talented people

were wasted" (Watson, *GPS News*, 2020). Li Guorui, a sent-down youth originally from Shanghai who was sent to Heilongjiang, was able to go to university but states that many of his friends who were sent with him "could not find good jobs upon return to Shanghai, all because of a lack of education", and that they stayed at the same low-level wage even after marriage and having children (Yang, Li, *Dartmouth Library*, 2022).

Had the teenagers not been sent to the countryside, a well-paying and stable job would be a given. However, because they were being sent to the countryside, opportunities for higher education such as university and therefore stable, well-paying jobs were not available to them. A lack of a good job and higher education hurts an individual's life and even their future children and families, as they are likely to maintain the same low-paying jobs their whole life. The sent-down youth's lack of such opportunities is a direct result of their participation in the Down to the Countryside Movement. Therefore, the Movement clearly marked a negative turning point for those whom it affected.

The social scars left by the Movement on Chinese society are mostly hidden. They do, however, occasionally come to light. In late March of 2019, the Communist Party released plans detailing voluntary trips to the countryside for university students, during which they would help develop impoverished villages. It sounds like an ordinary government initiative and fits in neatly alongside President Xi's plans to close the divide between rich cities and comparatively poorer rural villages. However, for the millions of former sent-down youth living across the country, it felt like the Down to the Countryside Movement was happening all over again. They took to the Internet to protest, fearful that history would repeat itself (Jiang, *CNN*, 2019). The Movement left enough of a negative impact that it was able to push protest to the surface, something that is remarkably rare in present-day China. The negative effects of the Movement, both at the time and in the future, were great enough and well-remembered enough by the former sent-down youth that a similar program was able to trigger those painful memories. It is obvious to conclude that the Movement was a negative turning point both for the entire country and for the individuals who experienced it.

Despite the many negative experiences associated with the Down to the Countryside Movement, it has led to some positive outcomes. For example, one study finds that the rates at which former sent-down youth attended college after 1977, when university entrance exams reopened, was higher than the rate of other urban youth at the time (Xie, Yu, et al, *National Library of Medicine*, 2009). The Movement has also had some positive effects long-term on those who experienced it, taking an important role in shaping them into who they are now. As one sent-down youth puts it, the Movement gave her "an iron will to live through the toughest conditions" (You, *CNN*, 2012). Xi Jinping, the current President of China, himself was also a sent-down youth, having been sent to the poor province of Shaanxi when he was just fifteen. According to China's media, this experience shaped him into a "practical, thrifty person" and helped him to understand the "needs and concerns of the ordinary people". While it is undeniable that the Down to the Countryside Movement may have had some positive impacts, the negative ones by far overshadow them. It is also clear that the negative consequences of the Movement

made a far greater impact on the lives of former sent-down youth than whatever positive consequences may have come along with them.

In conclusion, the Down to the Countryside Movement was a negative turning point for both the individuals who experienced it and Chinese society as a whole. This is abundantly clear when the effects, both during and after the duration of the Movement, on individuals and the broader nation, are examined. These effects are highly negative, and change the lives of many for the worse. The trauma left by the Movement was enough to leave a lasting impact on China that is especially visible in moments of protest. From hard labor that resulted in poor health later in life to missing out on university to a lack of job and government aid opportunities, it is fairly easy to conclude that the Down to the Countryside Movement had an array of negative effects on the individuals uprooted by it, and on China itself.

Works Cited

Primary Sources

Branigan, Tania. "A tragedy pushed to the shadows: the truth about China's Cultural Revolution." *The Guardian*, 19 Jan. 2023, www.theguardian.com/world/2023/jan/19/tragedy-pushed-to-the-shadows-truth-about-china-cultural-revolution. Accessed 3 Oct. 2023.

Watson, Virginia. "Reflections of a harrowing journey through China's turbulent revolution." *GPS News*, UC San Diego, gpsnews.ucsd.edu/reflections-of-a-harrowing-journey-through-chinas-turbulent-revolution/?print=print. Accessed 22 Oct. 2023.

You, Tracy. "China's 'lost generation' recall hardships of Cultural Revolution." *CNN*, 24 Oct. 2012, www.cnn.com/2012/10/24/world/asia/china-lost-generation/index.html. Accessed 22 Oct. 2023.

> This article and interview helped my project greatly by exploring labor during the Movement, and life afterward. This source also helped me to understand one perspective and experience on the Down to the Countryside Movement throughout the Movement, and beyond.

Beng, Kor Kian. "Cultural Revolution ruined his life, says former sent-down youth." *The Straits Times*, 16 May 2016, www.straitstimes.com/asia/east-asia/cultural-revolution-ruined-his-life-says-former-sent-down-youth. Accessed 3 Oct. 2023.

Xie, Ye, Sagraves. "Down to the Countryside Movement." *Dartmouth Library*, Dartmouth, www.library.dartmouth.edu/digital/digital-collections/down-countryside-movement. Accessed 21 Dec. 2023.

Secondary Sources

Hille, Kathrin. "China's 'sent-down' youth." *Financial Times*, 20 Sept. 2013, www.ft.com/content/3d2ba75c-1fdf-11e3-8861-00144feab7de. Accessed 18 Sept. 2023.

Jiang, Steven. "China's Xi Jinping causes alarm with mass student trips to the country." *CNN*, 4 May 2019, www.cnn.com/2019/05/04/asia/china-youth-policy-intl/index.html. Accessed 6 Oct. 2023.

Ownby, David. "Qin Hui on Sent-Down Youth." www.readingthechinadream.com/qin-hui-on-sent-down-youth.html. Accessed 18 Sept. 2023.

> This article helped me understand the history and broader implications behind the Down to the Countryside Movement. It additionally aided my research by providing a view of the overall impact of the movement.

"SENT-DOWN YOUTH, DOWN TO THE COUNTRYSIDE IN THE CULTURAL REVOLUTION." *Facts and Details*, Aug. 2021, factsanddetails.com/china/cat2/sub6/entry-5533.html. Accessed 21 Oct. 2023.

Weiyi, Wu, and Fan Hong. "The Rise And Fall Of The 'Up To The Mountains And Down To The Countryside' Movement: A Historical Review." *Rozenberg Quarterly*. *Rozenberg Quarterly*, rozenbergquarterly.com/the-rise-and-fall-of-the-up-to-the-mountains-and-down-to-the-countryside-movement-a-historical-review/. Accessed 21 Oct. 2023.

Wenqi, Ding. "Hundreds of Mao's Cultural Revolution 'Urban Youth' Protest Over Low Pensions." Translated by Lusietta Mudie. *Radio Free Asia*, 15 Dec. 2016, www.rfa.org/english/news/china/hundreds-of-maos-cultural-revolution-urban-youth-protest-over-low-pensions-12152016105823.html. Accessed 27 Oct. 2023.

Xia, Yameng. *Fate of women sent-down youths during the Up to the Mountains and Down to the Countryside Movement*. MA thesis. *colombia.edu*, Columbia University, academiccommons.columbia.edu/doi/10.7916/d8-dm9w-gw63/download. Accessed 18 Oct. 2023. Abstract.

Xie, Yu, et al. "DID SEND-DOWN EXPERIENCE BENEFIT YOUTH? A REEVALUATION OF THE SOCIAL CONSEQUENCES OF FORCED URBAN-RURAL MIGRATION DURING CHINA'S CULTURAL REVOLUTION*." *National Library of Medicine*, United States government, June 2008, www.ncbi.nlm.nih.gov/pmc/articles/PMC2597845/. Accessed 18 Sept. 2023.

The Duality of Hugh Hefner's Playboy Magazine: Misogyny, Queer Activism, and Divisions Within Social Progressive Movements By Julia Chang-Holt

Abstract

Playboy magazine, now 70 years old, has never been far from controversy. The public seems to find difficulty in reconciling Playboy's many complexities and apparent contradictions, as well as those of its founder Hugh Hefner. From its clubs that housed women clad in restrictive bunny suits to its dubious methods of obtaining pornographic images, Playboy in some ways was a prime example of misogyny through much of Hefner's reign. Even actions that might appear feminist on the surface, such as the magazine's support for abortion rights and disdain for traditional gender roles, can be understood as sexist when critically viewed in a larger context. However, more difficult to reconcile with this image is Playboy's consistent and authentic support of the LGBTQ+ community, well before the era of increased acceptance in popular opinion. From major philanthropic funding for AIDS research to outspoken advocacy for gay marriage, the company's support for the queer community has been undeniable. While it is easy to assume that feminism and advocacy for the LGBTQ+ community must go hand in hand, through Playboy we see that these social movements are not always aligned, as there is a critical difference between believing in equality between two binary genders and supporting complete freedom of gender identity and sexual orientation.

Introduction

World opinion seems divided on Playboy. The magazine and its founding publisher Hugh Hefner were two of the most notorious and controversial cultural phenomena of the 1960's, and remain the subject of heated debates, particularly surrounding their impact on women's rights. In obvious ways, the publication was overtly misogynistic. Even its self-proclaimed pro-feminist attitudes can be understood, with close analysis, to be fundamentally rooted in the male perspective. Many, however, find it difficult to reconcile this fact with Playboy's support and advocacy for the LGBTQ+ community long before that was a progressive touchstone. To understand this apparent contradiction, we must recognize and explore the important distinction between the *freedom* of gender and sexuality, which Hefner and Playboy ardently supported, and true *equality* among all groups based on identity and orientation, which they did not.

To understand Playboy's early impact on American culture, it is critical to appreciate the societal context in which it first appeared. The culture in America that set the stage for Playboy's popularity was one in which less traditional sexual activities were on the rise, even while the media and greater society remained hesitant to speak freely on those matters. Although there was a widespread cultural and sexual revolution during the 1960's, evidence suggests that sexual freedom within one's private sphere actually increased during the 1940's, before the first edition of Playboy in 1953. Statistics surrounding women having children outside of marriage, for example, point to a rise in premarital sex during the 1940's and into the 1950's. While individual Americans were more often taking sexually free actions, American society as a whole was not

ready to publicly accept this fact in the media or otherwise (Petigny 63-79). When the first issue of Playboy came out in 1953, it was an invitation for society to acknowledge publicly what had been going on privately in the prior decade.

Hefner created Playboy when he was newly out of college, deciding to focus the magazine's content on pornographic images and related articles. The magazine quickly gained widespread notice, leading to the creation of Playboy-related enterprises such as clubs and merchandise. Within twenty years, the magazine had reached its peak circulation of 7.16 million copies (Chemi). Created around the ideals of the destigmatization of sex, Playboy pushed back against the socially conservative approach to sex in the public sphere of the 1950's, a time when even married couples were required to be portrayed in separate beds on television (Motion Picture Producers). Hefner also connected these ideals to his self-proclaimed empowerment of women. He proudly stated, "I was a feminist before there was such a thing as feminism. That's a part of the history very few people know" (qtd. in Pitzulo 259-89). Despite his claim, even from its very beginnings his company showed evidence of sexism, in both obvious ways and those that were disguised behind the pretense of feminism.

Overt manifestations of misogyny in Playboy

Hefner's and Playboy's fundamentally misogynistic outlook can be observed through their treatment of female workers, the content of the magazine's published articles, and their approach to the acquisition and publication of pornographic images. In 1962, the young journalist Gloria Steinem went undercover as a Playboy Bunny, the title given to the female servers at Playboy clubs, to expose their treatment of female employees. She proceeded to write an article for *Show Magazine* detailing her experiences while working for the company. The female workers were severely underpaid when compared to the promises made in the job listings. When they complained, they were told that they were simply getting unlucky with tips. The company had complete control over the female workers' love lives, practically forcing them to accept propositions from "Number One Key-Holders" — men who paid a premium fee to get extra bonuses within the Playboy clubs. Steinem recounts an instance in which a fellow employee was fired when she refused a man's advances. The company's control promoted the idea of women as commodities to be bought and sold, dehumanizing them and taking away their autonomy. Steinem recalls being told during the hiring process, "[w]e don't like our girls to have any background…we just want you to fit the Bunny Image." The "Bunny Image," one characterized by uncomfortable rabbit costumes and a docile personality, stripped them of any personal identity, forcing every female employee into the same role. Steinem was also told that "[g]irls with colds usually have to be replaced," because a sneeze could break the zipper of the costume ("Bunny's Tale"). Firing workers for being sick reflects the emphasis placed on the girls' appearances over their health and wellbeing.

This dehumanizing treatment was also codified in the Playboy Club's "Bunny Manual" from 1969, which served as a rulebook for all of the female employees. The extensive rules dictated every aspect of an employee's life, both on and off the clock. Workers were not

permitted to eat or even drink water during a shift in front of guests, and had to use break time in order to do so. The clubs had a merit and demerit system with associated incentives and punishments. For example, an employee could gain demerits for actions as miniscule as wearing "too pale lipstick" or having bunny ears "not worn in center of head, bent incorrectly." The manual required that employees be on their feet in uncomfortable footwear for hours on end, and even suggested that workers should "soak them [their feet] in a solution of epsom salt and warm water" or could roll them "over an empty coke bottle." This extraordinary degree of control over the female workers' bodies point to Playboy's general lack of respect for women as independent human beings.

Hefner's misogynistic attitude can also be seen in the way women were portrayed in the articles he chose to publish. Playboy frequently published the work of known sexist writers such as Philip Wylie, who was infamous at the time for his ideas such as "momism," which painted women as destroyers of "male strength" (Pitzulo). He wrote many articles for Playboy because of his close connections to both Hefner and A.C. Spectorsky, the editorial director of the magazine, and these pieces featured notions such as "womanization," which suggested that women were essentially parasites who leeched off of men. Wylie claimed he was an "embattled man" who was "[taking] a look at what was once a man's world," in an article titled "The Womanization of America." Wylie's portrayal of himself and other men as victims was given widespread influence by Hefner's close association with him and his decision to publish his writings in Playboy.

Another example of overtly sexist writing in Playboy was a panel discussion published in the June 1962 issue that addressed the topic of the increasing power of women in society at the time ("Playboy Panel"). It began with an editorial statement which claimed that "the degree to which women have come to power in our society… has given grave cause for alarm to women as well as men." The panel consisted of eight men who bemoaned "society's reliance upon the specialized needs, whims, tastes and appetites of women" and expressed their belief that "women take it for granted that a man will chivalrously open doors, light cigarettes or yield his seat on a bus, yet offer him no such return courtesy[.]" The panel also claimed that in recent years women had become "more selfish, more greedy, less romantic, less warm, more lusty, and also more filled with hate." At a time when women still earned on average 60% of what men did (Walsh), this panel's statements clearly reflect a high degree of sexism and prejudice and ignored the fact that women still had the underhand in society, in the workplace and elsewhere.[7]

Finally, Hefner's sexism was evident in the way he presented the pornographic material, around which the entirety of Playboy and its related enterprises were built. When confronted with backlash regarding his use of pornography, Hefner claimed, "[t]he suggestion that somehow you can have a society that celebrates sexuality and then feels demeaned by images of sexuality is bizarre" (qtd. in Pitzulo). Nonetheless, Hefner refused to acknowledge the intrinsic issues with only promoting nude photographs of women in a manner targeted towards the fulfillment of male satisfaction. Hefner's method of "celebrating" sexuality was, in reality, an objectification of

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[7] Equal pay legislation would not be passed until a year later, in 1963.

women meant solely for the pleasure of his male readers (Pitzulo). In addition, Playboy did not always compensate female models appropriately for the use of their images. In the most famous example, a nude photograph of Marilyn Monroe was used as the centerfold of the first edition of Playboy without her explicit consent, with Hefner having purchased the photo from a calendar company without paying Monroe directly (Izadi). On other occasions, women were paid only $100 to $300 to pose for the magazine (Mansfield).

Playboy's apparent feminism and its true underpinnings

Some feminist commentators like Camille Paglia have praised Hefner for ideas that they considered truly liberating for women (Pyun). While indeed there were several longstanding examples of apparently pro-feminist ideas and actions promoted by Playboy, a close analysis reveals that fundamentally the company's actions were completely rooted in the male perspective. Two notable examples of Playboy's seemingly feminist values were its promotion of more modern gender roles and the destigmatization of sex. The Playboy company discouraged traditional gender roles in marriage, and encouraged women and men alike to break away from the conventional roles of the nurturing mother or the breadwinner father. It encouraged free conversations about sexuality, promoted premarital sex, and pushed society toward having a more understanding and open view of sex (Fraterrigo). These values both aligned with and contributed to larger changes happening in society at the time. The sexual revolution of the 1960's was a cultural movement that encouraged sexual freedom for all. As Smith notes, premarital sex showed a rise in approval ratings between the 1960's and the 1980's. Sex education in schools also became widely supported beginning in the 1960's, and contraception was legalized and popularized in the early 1960's as well (Smith 415-35). Playboy actively supported these initiatives, for example extensively covering and financially supporting the cause of an employee of a birth control manufacturer who was arrested for illegally distributing contraceptives (Tishgart). As a company with widespread influence and a publication with widespread readership, Playboy's opinions undoubtedly had a large impact on societal views of these important topics.

Playboy also took apparently liberal and feminist stances on some important topics such as abortion, and contributed to related philanthropic causes. In 2019, Yuko reviewed a timeline of Playboy's actions related to abortion and found the following. An article published in December 1965 stated, "[a] pregnant woman is faced with choices—and we think she should be allowed to decide which alternative is preferable under the circumstances—whatever the circumstances happen to be." In a later issue in May 1967, Playboy encouraged its readers to push their political leaders to "liberalize antiquated abortion statutes" in 12 states. Playboy not only made its pro-choice stance clear in its writing, but also in its financial support of feminist organizations. The company's associated philanthropic organization, called the Playboy Foundation, donated to groups that aligned with the company's values, and in 1966 began to financially support many pro-choice groups. It awarded a grant to the Association for the Study of Abortion, for example, and donated to other organizations such as the National Association for the Repeal of Abortion

Laws, the Women's National Abortion Coalitions, and the American Civil Liberties Union Women's Rights Project. Ruth Bader Ginsburg, the co-founder of the last mentioned organization, even discussed "the Playboy Foundation's generous support" in a letter written to the magazine. On a more individual basis, the Playboy Foundation donated to the Center for Constitution Rights in support of Shirley Wheeler, a 22-year-old woman who, in July 1970, was the first woman charged with manslaughter for having an abortion. The foundation financially supported Cyril Means, who filed on Wheeler's behalf against the charges levied against her (Yuko). Even beyond its support of abortion rights, the company took a progressive stance on working women, donating to organizations that funded childcare centers for working mothers and supporting women in the workforce (Pitzulo).

The financial support from Playboy given toward a variety of pro-choice and liberal organizations was likely helpful to many women around the country, and the larger messaging and social impact of Hefner's and Playboy's views should not be ignored. Yet in fully analyzing the aspects of feminism that Hefner supported, it becomes clear that he cherry-picked causes that benefited the male perspective. His pro-choice stance, although it stood out in its advocacy for women especially before Roe. v Wade, was actually rooted in self-interest for men. Men could have sexual freedom without the "burden" of becoming a father if women could have free access to abortions. Hefner's lack of respect for the consent and autonomy of his employees suggests that his support for abortion did not stem from a true consideration for women's free choice. Similarly, although Hefner adamantly supported breaking down the stereotype of the stay-at-home mother or nurturing wife, he did this merely to popularize a new stereotype of the woman as sexual being. Rather than encouraging a woman's own choice over her future and life, he simply replaced past stereotypes with new ones – promoting women as sexual objects that existed for male pleasure. An understanding of the broader context of Playboy's actions reveals, then, that Hefner's "feminist" actions were most likely rooted in sexist and self-serving intentions.

Support for the LGBTQ community

Although the analysis above makes Playboy's misogyny clear, there are other aspects of Playboy's social legacy that must be examined, in particular Hefner's support for the LGBTQ+ community[8] and the reconciliation of that support with the other facets of Playboy. Through the articles he published, Hefner was fairly clearly ahead of his time in being a vocal supporter of the queer community. In 1955, the science-fiction story "The Crooked Man," by Charles Beaumont, faced huge backlash because of its satirical commentary on and criticism of homophobia in society. Describing a world in which homosexuality was socially accepted and heterosexuals were ostracized, the piece was rejected by many magazines before being published in Playboy. In response to criticism of his choice to publish the story, Hefner remained unfazed and responded,

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[8] Different terms for the queer community were used at the time. This essay will use current terms such as "LGBTQ+" and "queer" to reflect this community.

"If it was wrong to persecute heterosexuals in a homosexual society, then the reverse was wrong, too" (qtd. in Brammer).

Playboy was also an early promoter of transgender rights. When model Caroline Cossey was outed as transgender and faced major public criticism in the 1980's, Playboy agreed to feature her as a model, long before broader trans acceptance in the popular media was present (Reynolds). Playboy's choice to present Cossey as a woman who could model just like anyone else reflects the highly progressive stance it took toward the LGBTQ+ community, long before that was commonplace in other media outlets.

Playboy was also an influential voice in confronting the AIDS crisis of the 1980's, which predominantly affected the gay male community at the time. Through financial support, personal advocacy, and the content of Playboy's articles themselves, Hefner again took a progressive stance on this societal crisis. In fact, the 40th anniversary gala of the magazine specifically raised funds for the American Foundation for AIDS Research. In 1983, shortly after the public emergence of HIV, the Playboy Foundation financially supported researchers at the New York University Medical Center to continue scientific investigations into the diagnosis and treatment of AIDS. Hefner himself donated over one million dollars to various organizations attempting to address the epidemic via education, research, and other methods. Importantly, he also offered his vocal support and advocacy for AIDS-related causes and was an original leading figure of the National Leadership Coalition on AIDS. His public stance during a period of many polarized opinions on the matter would likely have held sway with many Americans at the time. In an interview with *The Advocate* in 1994, Hefner said, "The only thing 'wrong' with AIDS is the way our government responded to it" (qtd. in Yarbrough). Playboy itself actively spread awareness about AIDS in its published articles as well. Beginning in July 1983, published pieces discussed methods of safe sex, the scientific basis of the disease, and other relevant topics (Yarbrough). These articles opened up the public conversation on AIDS and undoubtedly contributed to the destigmatization of the disease for its readers.

Hefner also wrote frequently in support of gay marriage rights in Playboy's pages. He adamantly argued in a September 2012 issue that "Denying them [LGBTQ+ individuals] the right to marry" is an "assault [on] the right of gays" (qtd. in Gavin). He particularly spoke out in opposition to "business owners and employers [who]... discriminate against gays on religious grounds," pointing out the importance of the separation of church and state (Gavin). His strong support of gay marriage aligned with his value of freedom within one's personal life, and particularly the freedom to love and marry whomever one chose without government interference. Besides his theoretical arguments about government control and the separation of church and state, Hefner also supported gay marriage in a more personal and emotional way. He argued that in regards to all marriage partnerships, "Two against the world is better than one" (qtd. in Yarbrough). Similarly, he told The Daily Beast that "Love in its various permutations is what we need more of in this world" (qtd. in Garcia). In a world that often separates or distinguishes different types of love, Hefner viewed marriage as a partnership that all should value, regardless of gender. As a public figure, his own speaking out on this topic was received

by a large audience and likely influenced the opinions of many. Unlike the fundamental pro-male perspective that appears to underlie Hefner's support of seemingly feminist causes, there is no obvious comparable explanation for his and Playboy's support of the queer community, besides a genuine belief in the freedom of gender identity and sexual orientation.

Reconciling misogyny and queer acceptance

Feminism and support for queer rights are often seen in contemporary times as going hand in hand, as allied progressive social movements, and in that way, Playboy's support of the queer community in the 1960's would seem difficult to reconcile with the misogynistic attitudes and behaviors that were discussed earlier. In reality, however, it is important to differentiate between supporting the rights of individuals to express their gender and sexuality freely and supporting equal treatment and opportunity between men and women as two binary genders. Indeed, this distinction is reflected in the documented history of feminism in the mid-twentieth century, the published principles of prominent international institutions, and Hefner's own statements about gender equality and gay rights.

Even early on, the goals of the feminist movement and those of the gay rights movement were often at odds with each other due to the former's focus on expanding social equality for heterosexual women alone. Activists in the second wave of feminism,[9] who shifted priorities from suffrage rights and legal equality to larger societal equity for women, sometimes excluded lesbian women out of concern that they would "hurt the movement by devaluing or delegitimizing it" (Coleman). These tensions continued into the 1970's and even early 1980's, manifesting dramatically in the 1982 Barnard Conference on Sexuality, an academic gathering that excluded certain prominent feminists who had a more traditional view of sexual activity. These women picketed outside the conference, and the divide between these two strains of thought was highlighted in a very public way (Echols). Similarly, gay male activists, though they were often inspired by women's rights protestors, have sometimes been criticized for not advocating enough on the side of feminists in the latter's fight against gender-based prejudice affecting women (Barksdale).

This distinction between binary gender equality and full freedom of sexuality is still present today, even at the highest international levels. The United Nations' official website describes gender equality as "full equality of rights and opportunities between men and women." This phrasing reflects a strict gender binary and points to a lack of gender inclusivity, even though the statement itself appears to promote equality. Similarly, the World Health Organization and its Programme for Gender Equality, Human Rights & Health Equity express an aim to "achieve gender equality and empower all women and girls," again indicating a focus on two distinct genders while not commenting on a fuller freedom of sexual and gender expression. The International Monetary Fund's "Strategy for Gender" seeks to achieve "equality between men and women" by increasing "women's economic participation," among other things.

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[9] Scholars generally place this between the 1960's and 1990's.

Hefner's own statements reveal the distinction in his mind between gender equality and true sexual liberation. In an internal memo about those he called "militant feminists," he wrote, "[t]hese chicks are our natural enemy" (qtd. in Mansnerus) and in his 1994 interview with the Advocate, he bemoaned the sexual prudishness of some feminists. In the very same interview, he expressed dismay about the prevalence of homophobia, stating that "sex is just a natural expression of our humanity. It's so stupid that some people can only accept what is natural to *them*" (qtd. in Yarbrough). His strong simultaneous belief in these two statements reflects the clear divide between them in Hefner's mind.

One can conclude, then, that Hefner and Playboy made the same type of distinction in their philosophy as other social movements and international institutions. As discussed above, Playboy supported freedom of sexual expression by publishing works about homosexuality that other outlets had rejected, featuring a transgender model in the face of major criticism, confronting the AIDS crisis in words and action at a time when the disease was strongly associated with the gay community, and advocating for same-sex marriage rights. Yet simultaneously, Playboy was undeniably misogynistic in its treatment of female employees, inclusion of articles that rued the supposed feminist takeover of society by women, and the nature and means of acquisition of its pornographic content. Hefner and Playboy seemed to believe that while all genders were not equal and did not need to be treated as such, any human being should still have the freedom to express their gender and sexuality in any way they wished. The evidence we have provided above suggests a duality of thought and behavior on the part of Hefner when it comes to gender equality and sexual freedom.

The post-Hefner Playboy of today

Hugh Hefner died in September 2017. The Hefner family is no longer associated with Playboy, and the current company has a different model for its future, one that includes "[confronting] any parts of our legacy that do not reflect our values today" and "building upon the aspects of our legacy that have made a positive impact" ("Open Letter"). Since ownership has changed, Playboy has only continued to support LGBTQ+ rights and to push the boundaries of societal acceptance of different genders and sexualities. Playboy included its first transgender Playmate[10] in 2017, again being on the front lines of trans representation in media (Salam). In 2019, the company launched its "PRIDE IS GOOD" campaign, which, in collaboration with the Trevor Project, helps fight homosexuality conversion therapy across the United States. In order to promote this endeavor, Playboy hired seven queer artists to create their own version of the iconic Playboy bunny ears with the question, "What does pride mean to you?" in mind, the results of which were published in an exclusive collection ("Pride"). The first gay male cover model appeared in 2021. The star, Filipino-American internet personality Bretman Rock, described the experience as "a huge deal for the LGBT community," and this milestone was praised by GLAAD's head of talent as a "powerful step forward in the ongoing movement towards greater diversity and inclusion in fashion and modeling" (qtd. in Lavietes).

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[10] A "Playmate" was the name for a Playboy model who was featured on the centerfold.

At the same time, Playboy's influence on American society is clearly waning. A TV drama on NBC in 2011 based on the Playboy Club of the 1960's drew such low ratings that it was canceled after just three episodes ("Centrefolded"). By 2017, more than 60 years old, the magazine had a circulation of only 400,000, a tiny fraction of what it was at its peak, when a quarter of American college men received a copy each month (Acocella; Bennett). The magazine stopped its print edition in 2020, and the newly relaunched digital version in 2023 is more of a platform for individual content creators (Spangler).

Despite Playboy's waning popularity, its legacy from Hefner's time remains powerfully with us as we continue to debate issues regarding the individual's right to autonomy and freedom of expression in the context of societal norms and expectations. We have seen how Hefner could simultaneously be called both the "ultimate enemy of women" (Bendel) and a "gay rights pioneer" (Garcia). The dichotomy that seems difficult to reconcile within Playboy, however, is merely a single institutional example of a distinct difference in the views and goals of two different progressive movements arguing for social change. It remains unclear where the national conversation on gender equality and sexual freedom will go in the future. However, understanding the distinction present in Playboy can help push our society to find more progressive views when it comes to full equality for all.

Works Cited

Acocella, Joan. "The Girls Next Door." *The New Yorker*, 12 Mar. 2006.
www.newyorker.com/magazine/2006/03/20/the-girls-next-door-2.

Barksdale, Aaron. "Why More Gay Men Need to Claim Feminism." *Huffington Post*, 8 Sep.
2015. www.huffpost.com/entry/more-gay-men-need-to-claim-feminism_b_8106446.

Bennett, Jessica. "Will the Millennials Save Playboy?" *New York Times,* 2 Aug. 2019.
www.nytimes.com/2019/08/02/business/woke-playboy-millennials.html.

Bindel, Julie. "Hugh Hefner was the ultimate enemy of women–no feminist anywhere will shed a
tear at his death." *The Independent*, 29 Sep. 2017.
www.independent.co.uk/voices/hugh-hefner-dead-death-playboy-mansion-bunny-women-m
isogynist-predatory-enemy-a7972046.html.

Brammer, John Paul. "Playboy Founder Hugh Hefner: An Early Proponent of LGBTQ Rights."
NBC News, 28 Sep. 2017.
www.nbcnews.com/feature/nbc-out/playboy-founder-hugh-hefner-early-proponent-lgbtq-rig
hts-n805591.

"Centrefolded: NBC cancels The Playboy Club." *Reuters*, 4 Oct. 2011.
nationalpost.com/entertainment/centrefolded-nbc-cancels-playboy-club.

Chemi, Eric. "Playboy magazine, by the numbers." *CNBC*, 11 Dec. 2015.
www.cnbc.com/2015/12/11/playboy-magazine-by-the-numbers.html.

Coleman, Katie. "1.4: Waves of Feminism." In *Introduction to Gender Studies*, Open Education
Resource (OER) LibreTexts Project.
socialsci.libretexts.org/Bookshelves/Gender_Studies/Introduction_to_Gender_Studies_(Col
eman)/01%3A_Introduction/1.04%3A_Waves_of_Feminism.

Echols, Alice. "Retrospective: Tangled Up in Pleasure and Danger." *Signs: Journal of Women in
Culture and Society*, vol. 42, no. 1, 2016.
www.journals.uchicago.edu/doi/full/10.1086/686751.

Fraterrigo, Elizabeth. *Playboy and the Making of the Good Life in Modern America.* Oxford
University Press, 2009.

Garcia, Michelle. "Hugh Hefner, Gay Rights Pioneer." *The Advocate*, 28 Aug. 2009.
www.advocate.com/news/daily-news/2009/08/28/hugh-hefner-gay-rights-pioneer.

Gavin, Patrick. "Hefner: Gay rights under 'assault'." *Politico,* 21 Aug. 2012.
www.politico.com/story/2012/08/hefner-gay-rights-under-assault-079930.

"Gender Equality." United Nations. www.un.org/en/global-issues/gender-equality. Accessed 31
Dec. 2023.

"Gender: Overview." International Monetary Fund. www.imf.org/en/Topics/Gender. Accessed 31
Dec. 2023.

Izadi, Elahe. "Marilyn Monroe helped launch Hugh Hefner's career. But they never even met."
Washington Post, 28 Sep. 2017.
www.washingtonpost.com/news/arts-and-entertainment/wp/2017/09/28/marilyn-monroe-hel
ped-launch-hugh-hefners-career-but-they-never-even-met/.

Lavietes, Matt. "Bretman Rock becomes Playboy's first gay male cover star." *NBC News*, 4 Oct. 2021.
www.nbcnews.com/nbc-out/out-pop-culture/bretman-rock-becomes-playboys-first-gay-male-cover-star-rcna2562.

Mansfield, Stephanie. "After Posing for Playboy…" *Washington Post*, 13 Oct. 1980. www.washingtonpost.com/archive/lifestyle/1980/10/13/after-posing-for-playboy/04f1f017-65a9-44b7-9723-da016a5e12c7/.

Motion Picture Producers and Distributors of America. "The Don'ts and Be Carefuls." 1927. wabashcenter.wabash.edu/syllabi/w/weisenfeld/rel160/donts.html.

"An Open Letter to Our Team & Community." PLBY Group Leadership Team, 21 Jan. 2022. playboy.medium.com/an-open-letter-to-our-team-community-9e3f1a68b0aa.

Petigny, Alan. "Illegitimacy, Postwar Psychology, and the Reperiodization of the Sexual Revolution." *Journal of Social History,* vol. 38, no. 1, 2004, pp. 63-79. www.jstor.org/stable/3790027.

Pitzulo, Carrie. "The Battle in Every Man's Bed: 'Playboy' and the Fiery Feminists." *Journal of the History of Sexuality*, vol. 17, no. 2, 2008, pp. 259-89. www.jstor.org/stable/30114220.

Playboy Club. "Bunny Manual." 1969. ia600501.us.archive.org/28/items/1969-bunnymanual/1969-bunnymanual.pdf.

"The Playboy Panel: The Womanization of America." *Playboy*, Jun. 1962. pipeandpjspictorials.wordpress.com/2021/07/16/the-playboy-panel-the-womanization-of-america-june-1962/.

"Pride Is Good." The Playboy Editors, 1 Jun. 2019. www.playboy.com/read/pride-is-good.

Programme for Gender Equity, Human Rights & Health Equity, World Health Organization, "About Us." www.who.int/teams/gender-equity-and-human-rights/about. Accessed 31 Dec. 2023.

Pyun, Jeanie. "Camille Paglia on Hugh Hefner's Legacy, Trump's Masculinity and Feminism's Sex Phobia." *Hollywood Reporter,* 2 Oct. 2017.
www.hollywoodreporter.com/news/general-news/camille-paglia-hugh-hefners-legacy-trumps-masculinity-feminisms-sex-phobia-1044769/.

Reynolds, Chelsea. "Hanging Up the Smoking Jacket: Productive Oppression and Playboy's Impacts on Mediated Sexualization." *Journal of Magazine Media,* vol. 18, no. 1, 2017. muse.jhu.edu/article/716087/pdf.

Salam, Maya. "Playboy to Feature Its First Transgender Playmate." *New York Times*, 19 Oct. 2017. www.nytimes.com/2017/10/19/arts/playboy-playmate-transgender.html.

Smith, Tom W. "A Report: The Sexual Revolution?" *The Public Opinion Quarterly*, vol. 54, no. 3, 1990, pp. 415-35. www.jstor.org/stable/2749376.

Spangler, Todd. "Playboy Magazine is Coming Back as Offshoot of Its OnlyFans-Like Creator Platform." *Variety,* 13 Mar. 2023. variety.com/2023/digital/news/playboy-magazine-digital-nudity-onlyfans-no-pornography-1235552261/.

Steinem, Gloria. "A Bunny's Tale." *Show,* May (Part I) and Jun. (Part II) 1963.
web.archive.org/web/20141218105108/http://dlib.nyu.edu/undercover/sites/dlib.nyu.edu.un
dercover/files/documents/uploads/editors/Show-A%20Bunny's%20Tale-Part%20One-May
%201963.pdf.

dlib.nyu.edu/undercover/sites/dlib.nyu.edu.undercover/files/documents/uploads/editors/Show-A%
20Bunny%27s%20Tale-Part%20Two-June%201963.pdf.

Tishgart, Sierra. "Playboy Magazine's Unlikely History of Abortion-Rights Activism." *The Cut*,
28 Sep. 2017.
www.thecut.com/2017/09/hugh-hefner-playboy-magazine-abortion-rights.html.

Walsh, Kenneth T. "The 1960s: A Decade of Change for Women." *U.S. News & World Report*, 12
Mar. 2010.
www.usnews.com/news/articles/2010/03/12/the-1960s-a-decade-of-change-for-women.

Wylie, Philip. "The Womanization of America." *Playboy,* Sep. 1958.
pipeandpjspictorials.files.wordpress.com/2021/05/pic-195809-womanization.jpeg.

Yarbrough, Jeff. "Hugh Hefner: The Advocate Interview." *The Advocate*, Mar. 1994.
books.google.com/books?id=JGMEAAAAMBAJ&pg=PA38&lpg=PA38&dq=hugh+hefner
+advocate+jeff+yarborough&source=bl&ots=O0jNZV94sp&sig=ACfU3U3oURuAdIvAn7
PBFkngKUEQfImr_Q&hl=en&sa=X&ved=2ahUKEwip-ufL17qDAxWmSDABHc7hCQk
Q6AF6BAgiEAM#v=onepage&q=hugh%20hefner%20advocate%20jeff%20yarborough&f
=false.

Yuko, Elizabeth. "We Won't Go Back." *Playboy*, Summer 2019.
www.playboy.com/read/we-won-t-go-back.

Catastrophic Complacency: Unveiling the Economic Ignorance that Ignited the 21ˢᵗ Century American Meltdown By Dithyae Devesh

In the late 1990's the interest in the internet became something out of a movie, the world went into a "digital frenzy," the values of equity markets rose exponentially, investors lost their minds with the boom of a new industry.[1] Backtrack about five years, the commercialization of the internet lead to a rapid and remarkable expansion of capital growth, the greatest the country had ever seen.[2] This frenzy grew into the dot-com bubble of the 1990's, where investors were splurging and companies, with even the most arbitrary products, began to generate an influx of revenue. Entrepreneurs tapped into the potential that spewed out of the internet industry and companies such as Amazon and Yahoo were born. So began the dot-com bubble of the late 1990s and early 2000s. A speculative economic bubble that held excessive optimism towards all internet companies as well as their stocks. A bubble that would eventually burst, barreling the world of the internet into its existence today, only to be followed by the greatest economic recession the world had seen since the Great Depression. In late 2007 America was hit by another instance of the lack of investor confidence and declines in credit which plummeted stock and commodity prices, just as they were trying to pick up after the dot-com bubble. To make matters even worse, a bubble was forming in the housing market. So, when homeowners began defaulting on home loans with a massive amount of consumer debt, it burst. The unregulated housing market stripped people of their homes, sending the economy into a tailspin. The problem? The watchdogs who were supposed to protect the country from financial harm were actually complicit in blowing up the American economy, in bursting these bubbles. The roles played by executives in the Federal Reserve, Goldman Sachs, and other enablers and players on Wall Street pushed investors to ignore the warning signs of imminent disaster.[3] The existence of a predatory nature in private mortgages, and lenders that were at fault perpetuated this problem. But, more importantly, U.S government officials and corporate leaders of financial institutions and their lack of transparency instigated this downfall. The complacency within the Federal Reserve, Wall Street, and their finance giants and ignorance and greed of several actors blew up the American economy in the dot-com crisis, and the housing bubble that followed shortly after, preceding the massive 2008 recession, barreling America into its current economic state.

In the prelude of the dot-com bubble, lower interest rates increased the availability of capital, where extreme inflation led to high interest rates to contain inflation.[4] The 1990's were a period with significant advancements in technologies, with the invention of the Mosaic in 1993, the world's first internet browser, allowing individuals to access the World Wide Web from the comfort of their own devices.[1] With the Taxpayer Relief Act of 1997, lowering the top marginal capital gains tax in the United States, it increased the incentive for people to make more speculative investments, especially as the internet industry continued its growth.[5] But, it was Alan Greenspan, chairman of the federal reserve and a top financial regulator, that fueled investments into the stock market by putting a positive spin on stock valuations.[6] With an

expectation of many new technologies, people wanted to profit off them and were eager to invest at any valuation of any dot-com company. With rapidly increasing stock prices and a confidence that companies would have large profits in the future, an environment of investors looking past traditional metrics was created.[7]

But it wasn't just on the investors, someone had to be feeding them a belief that this was a good idea, so in came The Federal Reserve and their cycle of economic collapse. The bank would lower interest rates making it cheap for people to borrow money leading to malinvestment and the existence of a bubble. Then, the economy would overheat forcing the bank to raise its interest rates once again, bursting the bubble. People were then unable to borrow, causing economic downturn, and the only way to recover was if the Fed lowered rates again to boost investment, starting the cycle all over.[8] So, in 1999, to fend off the impact of Y2K, The Federal Reserve created too much money, "pouring gasoline on the smoldering fire of stock markets."[9] Dotcoms turned into the victims of their large economic forces and Greenspan exulted over these technological advancements regardless of the mania, and refused to calm down the euphoria. Instead of heightening scrutiny among the big banks they oversaw, the Federal Reserve backed institutions whose desires were to reduce capital requirements and increase their leverage of profits, loosening financial institutions in areas that could result in losses.[10] So, while the stock market was taking off in the most dangerous and unprecedented fashion, with the risk of collapsing at any minute, the Fed was busy feeding into investor delusions, swelling their appetites.

Investors were then able to hold all the power, whatever they say, went, and their greed and overhyping led countless people to ignore the warning signs of disaster, as they perpetuated the dot-com bubble crash. As the popularity of the internet grew, so did the enthusiasm for its usage as a tool for commerce as they took to the stock market. Their eyes grew for tech companies with profits deemed limitless, eager to jump into the next "hot stock".[11] The issue was investors used old investment tools to pressure startups to follow specific strategies and used reckless speed to implement them. But there was a middleman in between the investors and the Fed. Who? Venture capitalists. Venture capitalists poured money into numerous tech and internet start-ups.[12] For example, many venture firms pushed start-ups to pour money into advertising and establishing brand names, offering them tens of millions of dollars, more than ninety percent for mass-media advertising, which forced dotcoms to "toss fiscal responsibility out the window."[13] Investors saw the opportunity to make quick profits and jumped at the idea, encouraging others to join, which overhyped the value of dot-com companies. This overconfidence in their profitability and the abundance of venture capital for startups is what ultimately pushed the bubble over the edge. There were no proper plans made regarding businesses, products, or track records of earnings so nothing was remaining after all their cash was utilized, thus these companies crashed.[14]

These investors, some of whom were experienced financial analysts, did not fully understand how transformative and "futuristic" the internet was and were overly optimistic about the growth potential of internet-based companies, even the ones with flawed business

models. Their overenthusiastic nature led to the ignorance of some, and the complacency of more as their greed seeped into their work, tipping the bubble over the edge, and promise of profit led investors to be ignorant in investing into the bubble. But it was also this fear of missing out (FOMO) in this new rise of the economy. The rise of stocks for these internet business models pushed investors to join the bandwagon so they would not lose out on personal gains. An unexpected amount of people engaged in personal investing during the boom, as stories of people quitting their jobs to engage in full-time trading rose. The media took advantage of this. They capitalized on the public's desire to invest in the stock market with the same level of suspense networks gave to broadcasting sports events.[15] Sensationalized headlines like "A new economy" and "wealth creation" made the public believe this was a good idea and contributed to increasing the valuations of poor companies.[16] The desire for rapid financial gain created a sense of ignorance among investors who were prepared to ignore warning signs and due diligence when funding businesses with dubious and implausible business models. Around this same period, interest rates and the capital gains tax rates were at an all-time low, giving investors more capital to make speculative investments within these dot-com companies. But all good things must come to an end in the magical world these investors lived in during the dot-com bubble and the self-reinforcing loop of demand inflating stock prices and fueling the bubble burst. With the Federal Reserve's loose monetary policy of lowering interest rates, making cheaper borrowing and encouraging businesses and investors to take more risks, the overhype and overvaluation of dot-com companies blew up the bubble and thus the economy followed it. The burst of the dot-com bubble preceded a recession only to be followed by the attack on September 11, 2001. And with the pop of one bubble came upon a second one, this time in the housing market. But to the Federal Reserve, it was not to be feared. As a matter of fact, Alan Greenspan considered home equity extraction to be beneficial to society and the economy, especially after the previous tragedies.[17] So rather than leveling a warning that a housing bubble meant owners were draining their savings, he applauded the economic stimulus created by the bubble because central banks, globally, tried to stimulate the economy as a response, and as a result, created capital liquidity through a reduction in interest rates.[18] Greenspan wasn't done yet. In fact, he dismissed comparisons between the real-estate and stock markets. He said that house prices reflected a rise in immigration and a shortage in building land, but of course his true intentions were to keep the housing market running.[19] He continued to tell the world that the housing market was "perfectly fine" and bubbles were reasonable.[20] He relied on the housing book to offset a precipitate fall in business investment in hopes of succeeding in exploiting the "buoyant housing market to prevent a double-dip recession."[21]

      The Federal Reserve's "see no bubble" mentality is what pushed the housing bubble over the edge. Fed economists made numerous other miscalculations regarding debt levels in real estate, however. Their calculations ignored crucial changes in the housing market, downplaying risks that a real estate crash would pose to consumers and banks. The Fed reported that it would save tens of thousands of dollars to take adjustable-rate mortgage loans (ARMs) rather than traditional fixed mortgage rates, forcing banks to issue mortgages to uncreditworthy people.[22]

But the Fed couldn't keep this up forever so they increased the federal funds rate to 4.25 percent, and people began to miss their mortgage payments because of increased monthly burdens.[23] Many people defaulted on their mortgages due to the adjustable rates their own government encouraged them to take. And so, the government's complacency crashed the bubble. Ben Bernanke, Alan Greenspan's successor, even signaled a disinterest in identifying asset bubbles in a speech in his early tenure.[24] The Fed was too busy dismissing the existence of the housing bubble. America's political system in Washington allowed Wall Street to exercise the enormous influence that it had to push for stripping regulations and the appointment of regulators who didn't believe in them and Fed economists provided models–based on entirely unrealistic assumptions of a perfect market–in which regulation was unneeded.

But, the government's complacency trickled down to that of lenders. Under the belief that everything was fine, lenders advanced loans to all sorts of people, even ones with a high risk of default (when homeowners fail to uphold an agreement). The flood of money and credit, combined with various government policies designated for the sole purpose of encouraging homeownership, and a host of financial market innovations, increased the liquidity of real estate related assets. When the central banks flooded with capital liquidity, lenders had ample capital to lend, so just like investors, they too had an increased willingness to undertake additional risk and increase their own investment returns.[25] Their greed to hook more subprime borrowers, especially those with tarnished or limited credit histories, pushed them into giving the impression that these mortgages had no risk, and the costs were not high. Just like the Federal Reserve did, both institutions gaslighted borrowers into taking on mortgages they could not afford, which made effects unmanageable. So, when people finally connected the dots that the risk premium was too high for investors, they stopped buying houses and housing prices began to plummet, triggering a massive sell-off in mortgage-backed securities (MBS), an investment that consists of a bundle of home loans bought from the banks that issued them.

But in between the government and the lenders and investors were the investment banks. These banks were supposed to be "risk management experts."[26] But, not only did they fail to manage any risk, they actually created it. Banks engaged in excessive leverage. A thirty-to-one leverage ratio, to be precise. To put things into perspective, a three percent change in asset value is enough to wipe out one's net worth. These banks adopted incentive strategies designed to induce short-sighted and excessively risky behavior.[27] To give them the benefit of the doubt, maybe investment banks did not understand the risk of securitization. But their only other mechanism of blame, the investors made them do it. Yet, in reality, it was the banks that exploited investor ignorance to push their stock prices up in order to receive higher short-term returns, at the expense of significantly higher risk.[28] Investors' lack of interest preempted mortgage brokers' lack of interest in originating good mortgages, as they were more incentivized in originating more mortgages to appeal to more eager investors. Some mortgage brokers were so enthusiastic that they invented new forms or mortgages like low-or-no documentation loans, an invitation to deception, which became known as liar loans.[29] These loans lead to more lending, more buying, and thus, more defaulting as poorer candidates were chosen, which meant

a popping bubble.

Securitization led to investment banks' failure to regulate which not only led to their own downfall, but the downfall of the economy. During the housing bubble, hedge funds sold mortgage-backed securities and bundled one mortgage with several other similar ones and sold it to investors, making new loans with the money they were receiving.[30] So while they were "risk free" investors took all the risk of default, yet there was no worry because they had insurance which allowed them to snap up the derivatives, paving way for everyone to own them. A derivative backed by the combination of real estate and insurance was very profitable, causing banks' demand for more mortgages to back the securities. To meet this demand, banks and mortgage brokers offered home loans to just about anyone. In October of 2004 the Securities and Exchange Commission (SEC) relaxed the net capital requirements for five investment banks, Goldman Sachs, Merrill Lynch, Lehman Brothers, Bear Storms, and Morgan Stanley, allowing them to leverage their initial investments by up to thirty or forty times.[31] So when the housing bubble burst, leaving the most vulnerable subprime borrowers stuck with mortgages they could never afford, one subprime lender after another began to file for bankruptcy. These were the same financial institutions that engaged in widespread securities fraud and predatory lending that began as early as 2003.[32]

The Lehman brothers, specifically, created a huge shock wave. Because they were a global financial services firm, not a bank, it was not overseen by the Fed, so they funded themselves in short-term markets, investing heavily in mortgage-related securities. The Lehman Brothers specifically fell from their own complacency in the bubble. Their poor control of risk management and questionable accounting led to their demise. They were highly leveraged, due to their own adoption of an aggressive growth strategy supported by limited equity. As housing prices fell and delinquencies on mortgages rose, Lehman's financial position declined, hemorrhaging large amounts of funds. Creditors lost their confidence claiming they were "afraid they're not going to be here next week."[33] Eventually, Lehman turned illiquid and lacked any sufficient collateral to borrow from the Fed or renew the repurchase agreement contracts to avert a collapse.[34] And so, they filed for bankruptcy, and the commercial paper they issued became worthless and investors scrambled to pull out their money. The Fed and the Treasury had to respond quickly as they gave investors a temporary guarantee that if they did not pull out their money right away, they would get their money back, and the Fed created a backstop liquidity program.[35] The irony? From Wall Street to Washington, the fundamental failure of their own firms perpetuated the financial crisis. Wall Street individuals took irresponsible risks that Washington did not have the ability to constrain. But, it was Washington who started it all and pushed it onto the banks.

When securitization failed, asset values collapsed and banks became increasingly hesitant to lend, which meant the lending market froze. Many banks found themselves with impaired balance sheets, facing a situation where their liabilities exceeded their assets.[36] Like Lehman Brothers, not all banks could bear the brunt of the financial storm and were forced to file for bankruptcy, or like Bear Storms, required government intervention and mergers to

survive.[37] America was pushed into a wave of bank failures, acquisitions, and consolidations. But even after their collapse, the Federal Reserve still showed little recognition that a serious economic downturn was underway. Rather, the committee relied on the framework of macroeconomics to mitigate the seriousness of the crisis, justifying that markets were working rationally.

But the crash and recession proved to America that they never should've ignored this, never have been so oblivious. But not everybody fell apart. In the wake of the dot-com bubble, tycoons like Amazon made it through. And post-financial recession, Goldman Sachs still survived. The pressing question, how did they do it? Goldman Sachs obtained credit risk insurance from the American International Group (AIG), the financial and insurance corporation. So even though the insurance went bankrupt, they were prepared. AIG received a bailout, and so Goldman received a bailout because of their connections. Goldman made the smart decision to diversify its risks well before the crisis. As for Amazon, while their stock prices rose from $2.50 to $107 in just two years they focused on innovation and expansion, not catering to investor greed.[38] Companies like eBay, too, adapted through reorganization, new leadership, and redefined business plans.[39] Amazon raised a significant amount of money right before the market crashed, giving it a large cushion to ride out the dot-com bubble turmoil.

When one domino falls, the rest come crashing down and that is exactly what happened in the late 1990s and early 2000s. The rise of the internet perpetuated a demolition in the American economy as the greed rose in different actors, all looking to make a huge payout in a brand-new system. When the dot com bubble crashed investors were not ready for the hype to end and turned to housing instead, forcing the Fed to raise their rates. But really, the Fed didn't care, they were too ignorant to the state of the economy to understand that their actions had serious consequences, because to them, the housing market was supposed to always be stable. After all, it was just the housing market. But these consequences caused risk to grow in investment banks and lenders. All of these actions put America into their worst state since the Great Depression. This financial crisis revealed the need to rethink how financial systems are regulated. Following the first crisis a new value of the importance of good customer experience in digital commerce and doing business on the internet was established. No more overvaluations of companies that truly had no purpose other than to support a hype. As for the recession, new laws and promises were made. Banks were bailed out and the government threw lifelines at federally-backed institutions. The Dodd-Frank Wall Street Reform and Consumer Protection Act was implemented to enforce new and improved watch dogs onto Wall Street and banks raised their capital requirements, reduced their leverage, and thus were less exposed to subprime leverages.[40] It is not safe to say that the economy is going to be stable now, because that will never be guaranteed, however, denial and ignorance when dealing with a financial crisis only further perpetuates it. It is not the housing market or the dot-com companies' faults. It is the fault of everyone who saw it coming and chose to do nothing, or make it worse because of potential gain, that they probably ended up losing anyways. This concept holds true for generative AI today. Y Combinator, a startup accelerator company, has startups that are building

applications surrounding artificial intelligence. The number of startups they support has jumped from twenty percent to sixty percent, or more than 134 startups, all dealing with generative AI.[41] A worry exists that the artificial intelligent market, too, will enter its own bubble, with a demise nobody is prepared for.

Works Cited

Amadeo, Kimberly. "Causes of the 2008 Financial Crisis." *the balance*.
      https://www.thebalancemoney.com/
 what-caused-2008-global-financial-crisis-3306176#:~:text=Deregulation%20in%20the%
      20financial%20industry%20was%20the%20primary%20cause%20of,even%20those%20
      with%20questionable%20creditworthiness.

Bernanke, Ben S. *The Federal Reserve and the Financial Crisis*. Oxford: Princeton University
      Press, 2013.

Boyle, Michael J., ed. "2008 Recession: What It Was and What Caused It." Investopedia.
      https://www.investopedia.com/terms/g/ great
      recession.asp#:~:text=The%20root%20cause%20was%20excessive,the%20risk%20on%
      20to%20investors.

"Dot-Com Bubble." In *Gale Encyclopedia of U.S. Economic History*, 2nd ed., edited by
      Thomas Riggs, 340-41. Vol. 1. Farmington Hills, MI: Gale, 2015.
      https://link.gale.com/apps/doc/CX3611000250/
      UHIC?u=tlc109229116&sid=bookmark-UHIC&xid=3e686680.

"Dot-com Bubble." *Vaia*. https://www.hellovaia.com/explanations/macroeconomics/
      macroeconomics-examples/dot-com-bubble/ #:~:text=1995%20and%202000.-,
      It%20was%20an%20economic%20bubble%20that%20affected%
      20the%20prices%20of,bankruptcies%2C%20and%20increasing%20capital%20spending
      .

Friedman, Jeffrey, ed. *What Caused the Financial Crisis*. Philadelphia, PA: University of
      Pennsylvania Press, 2011.

Friedman, Walter A. Entrepreneurs and the global economy, 1980–2020 to *American Business
      History: A Very Short Introduction American Business History: A Very Short
      Introduction*, 119-34. https://doi.org/10.1093/actrade/ 9780190622473.003.0010.

Ironman, Political Calculations. "Here's Why The Dot Com Bubble Began And Why It
      Popped." *Business Insider*. https://www.businessinsider.com/
heres-why-the-dot-com-bubble-began-and-why-it-popped-2010-12.

Jurgilas, Marius, and Kevin J. Lansing. "Housing Bubbles and Homeownership Returns."
      Federal Reserve Bank of San Francisco.

Lewis, Michael. The Big Short. London, England: Norton, 2010.

Lewis, Michael. Panic. London, England: Norton, 2009.

Lewis, Michael. *The Story of Modern Financial Insanity*. New York, NY: W.W. Norton, 2009.

Lowesnstein, Roger. *Origins of the Crash: The Great Bubble and Its Undoing.* N.p.: Penguin
      Books, 2004

McCullough, Brian. *How the Internet Happened; From Netscape to the Iphone*. New York, NY:
      Liveright Publishing, 2018.

Mills, D. Quinn. "Who's to Blame for the Bubble?" *Harvard Business Review*.
      https://hbr.org/2001/05/whos-to-blame-for-the-bubble.

Morgenson, Gretchen, and Joshua Rosner. *Reckless Endangerment*. New York, NY: Times
     Book, 2011.

Nikolic, Luka. "A Tale of Two Bubbles: How the Fed Crashed the Tech and the Housing
     Markets." *FEE Stories*. https://fee.org/articles/
     a-tale-of-two-bubbles-how-the-fed-crashed-the-tech-and-the-housing-markets/.

Palazzolo, Stephanie. "What We Can Learn From AI Startups in Y Combinator's Latest Batch."
     The Information. https://www.theinformation.com/articles/
     what-we-can-learn-from-ai-startups-in-y-combinators-latest-batch.

Paluteder, Diana. "Dot-com Bubble Explained | the True Story of 1995-2000 Stock Market."
     Finbold, august 8, 2022. Accessed October 19, 2023.
     https://finbold.com/guide/dot-com-bubble/.

Soo, Brad. "The dotcom bubble 20 years on: Lessons learned?"
     https://commercetools.com/blog/ dotcom-bubble-lessons
     earned#:~:text=%E2%80%9CThe%20dot%2Dcom%20crash%20has,thei
     r%20market%20and%20mind%20share.

Sudhir, Sidharth. "The Dot-Com Bubble Explained." StreetFins.
     https://streetfins.com/the-dot-com-bubble-explained/.

Teeter, Preston, and Jörgen Sandberg. "Cracking the enigma of asset bubbles with narratives."
     SageJournals. https://journals.sagepub.com/doi/abs/ 10.1177/1476127016629880.

Weinberger, Matt. "History of the Dot Com Bubble in Photos." *Business Insider*.
     https://www.businessinsider.com/history-of-the-dot-com-bubble-in-photos-2016-2.

The Resurgence of "Yellow Peril" By Keven Pi

Introduction

The global landscape has been defined by the increasing ascendancy of China. Seen as the formidable challenge to the prevailing world order, China's rise was met with a strategic apprehension from the United States termed the "New China Scare."[11] Such trepidations are precedented in the pattern of historical anxieties during periods of power transitions and emergence of new rivals. Historically, the onset of the "Red Scare" marked the Western world's fear of the burgeoning influence of Bolshevism. Subsequently, before World War II, there was a palpable European unease regarding fascism and Germany's growing power. By the late 1980s, the United States grappled with the "Yellow Peril," a sentiment triggered by Japan's remarkable technological and economic advancement.[12] Presently, we are witnessing the resurgence of this "Yellow Peril" towards China and Chinese descendants.

The Trump administration's initiation of a trade conflict with China, under the banner of its "America First" policy, has inadvertently paved the way for a potential vacuum in global leadership—a situation the Biden administration has struggled to redress.[13] The Trump-led trade offensive against China can be interpreted as an attempt to recalibrate the existing Pax Americana. Given this backdrop, it's unsurprising that China's growing influence evokes strong apprehension. The prevailing worry goes beyond China's economic prowess, but rather encompasses concerns about China's unique civilizational ethos. Its culture, distinct state-centric economic model, and own brand of state capitalism evidently appears enigmatic to the Western gaze. Such fears have evolved beyond geopolitical sentiment, and has embedded themselves deeply within the socio-political fabric, fueling acts of hate and violence against East Asians in the U.S..

The surge in anti-Asian sentiment, catalyzed by the divisive political rhetoric born out of the China Scare, takes multiple forms. From the government's tendency to play the 'blame game' on issues like the economy and national security, to an alarming escalation in overt racism during the pandemic.[14] Moreover, institutionalized persecution manifests in various ways, such as the 2018 initiative against Chinese espionage that wrongfully implicated innocent scientists of Chinese descent, and assignment restrictions that curtailed the security clearance of Asian Americans based on xenophobic assumptions. The more recent TikTok hearings further underscore this pattern, revealing a xenophobic undercurrent within the U.S. government, thinly

[11]Daniel Lippman, "State Department ends 'assignment restrictions' policy that some called discriminatory," POLITICO, last modified March 22, 2023, accessed September 5, 2023, https://www.politico.com/news/2023/03/22/state-ends-assignment-restrictions-policy-00088310.

[12]Marjan Svetlicic, "FROM RED SCARE TO YELLOW PERIL: REALITY AND FEARS OF THE RISE OF CHINA IN A HISTORICAL CONTEXT," Teorija in Praksa, accessed September 5, 2023, https://www.researchgate.net/publication/347492455_Marjan_SVETLICIC_FROM_RED_SCARE_TO_YELLOW_PERIL_REALITY_AND_FEARS_OF_THE_RISE_OF_CHINA_IN_A_HISTORICAL_CONTEXT_1.

[13]Internationalist, "Global Uncertainty in an Age of 'America First,'" Council on Foreign Relations, last modified June 28, 2017, accessed September 5, 2023, https://www.cfr.org/blog/global-uncertainty-age-america-first.

[14]"The Blame Game," Stop AAPI Hate, last modified October 2022, accessed September 5, 2023, https://stopaapihate.org/wp-content/uploads/2022/10/Stop-AAPI-Hate-Scapegoating-Report.pdf.

veiled as concerns for national security. This trajectory not only marginalizes talent based on ethnicity but also undermines the nation's core principles, thereby perpetuating a vicious cycle. Concurrently, such a cycle amplifies orientalist narratives, which depict Eastern societies as exotic, backward, and potentially dangerous, thereby heightening perceived threats to Western identity.[15] In response, there is an urgent call for a comprehensive reevaluation of our educational systems, a move towards more nuanced and culturally sensitive pedagogical approaches, and a diversification of governmental institutions. Only by implementing such transformative measures can we hope to dismantle these harmful orientalist narratives and foster a society that embraces, rather than fears, its rapidly changing global landscape.

The Revival of the "Yellow Peril"

The historical "Yellow Peril" trope has re-emerged within the twenty-first century, to reflect shifting geopolitical dynamics and perpetuate anti-Asian sentiment and hostilities. The concept of this trope emerged in the late nineteenth and early twentieth centuries, coinciding with the influx of Chinese immigration to the West Coast of the United States. This stereotype was fueled by white Americans' antipathy to Chinese workers' propensity to accept jobs for lower wages, which in conjunction with racist perspective towards their inherent distinctiveness created the unfounded fears of a "Chinese invasion."[16] To amplify these fears, narratives were filled with ominous depictions of Chinese as threats to Western values and civilization. Consequently, they were often depicted as "exotic, heathen, and violent."[17] Such negative imagery served as a foundation for policies like the Chinese Exclusion Act of 1882, which instituted a decade-long ban on the immigration of Chinese laborers. As global dynamics shifted, especially with the rise of the Japanese Empire leading to World War II, the "Yellow Peril" narrative was repurposed and weaponized against other Asian Americans, particularly those with ties to Japan challenging Western and U.S. hegemony. This evolving stereotype, shaped by geopolitical tensions, not only legitimized the exploitation and marginalization of Asian Americans but also sought to control the narrative surrounding their role and identity within the U.S.

Today, we are confronted with the third iteration of the "Yellow Peril," a deep-seated apprehension directed towards China, primarily triggered by its rapid economic ascent. Since 2016, the focus on protecting American jobs from China's manufacturing strength has become a cornerstone of U.S. foreign policy and reflects a larger global shift towards more protectionism.[18] This policy orientation did not emerge in a vacuum; rather, it follows several decades of American corporate investment in foreign labor markets, particularly within China. Driven by

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[15]Edward W. Said, Orientalism (London: Penguin Books, 2003).

[16]Stanford M. Lyman, "The 'Yellow Peril' Mystique: Origins and Vicissitudes of a Racist Discourse," International Journal of Politics, Culture and Society 13, no. 4 (2000): 683–747, https://doi.org/10.1023/a:1022931309651.

[17]Neil Nakadate and William F. Wu, "The Yellow Peril: Chinese-Americans in American Fiction 1850-1940," MELUS 10, no. 3 (1983): 92-95, accessed September 5, 2023, https://doi.org/10.2307/467445.

[18]Per Altenberg, "Rising Protectionism Signals Valuable Lessons Have Been Forgotten," IISD, last modified July 28, 2021, accessed September 5, 2023, https://www.iisd.org/articles/rising-protectionism-signals-valuable-lessons-forgotten.

the enticement of lax regulatory frameworks and economically advantageous labor conditions, this investment strategy facilitated the withdrawal of large enterprises from the American labor market, and thereby imperiling the job security of a predominantly blue-collar workforce.[19]

This enduring divide in the American socio-political landscape set the stage for Donald Trump's electoral victory, anchored in a nationalist agenda and policies aimed at economic self-sufficiency. Trump's populist messaging amplified the concerns of voters primarily anxious about employment stability, channeling this discontent into a growing animosity against China. Although Trump's tenure in the executive branch concluded over two years ago, U.S.-China relations have seen marginal improvement at best. The Biden administration has persisted in upholding a series of antagonistic trade policies, including maintaining billions of dollars in tariffs on Chinese imports—measures originally instituted by Trump. Far from compelling China to acquiesce to American demands, these policies have proven counterproductive, inflicting economic pain on both American and Chinese citizens. China's retaliatory tariffs have similarly disadvantaged American consumers and enterprises, rendering the trade conflict a lose-lose proposition for both nations.[20]

The ongoing conflict enapsulates a broader antagonism that resonates with historical apprehensions: initially anchored in the formidable economic stature of emerging powers, and later transmuting into fears of external, often intangible threats. These perceived "dangers" emanate less from their tangible economic or technological advancements and more from their inherent distinctiveness. What started as economic concerns have morphed into ideological, cultural, religious, and racial anxieties, constructing an image of an "other" that is fundamentally alien to Western sensibilities.[21] Furthermore, the perspective is intricately tied to the longstanding ethnocentric view that often casts Western norms as the gold standard, relegating non-Western cultures, particularly those of the East, to a subordinate or even derogatory status. Historically, such views have been instrumental in justifying European imperial ventures and the subjugation of non-Western territories. These entrenched biases are being rekindled, painting China as a potential adversary to Western supremacy and ideals. Capitalizing on these renewed sentiments has led to the rise of ethno-nationalism and populism within the United States, which perpetuate a divisive narrative of "us versus them." The populist apprehension towards China's economic prowess, intertwined with deep-seated cultural misconceptions, feeds into the "Yellow Peril" narrative.

[19]Alex Brumfield, "The U.S. Has a Deep-Rooted Sinophobia Problem," International Relations Review, last modified May 27, 2023, accessed September 5, 2023,
https://www.irreview.org/articles/the-us-has-a-deep-rooted-sinophobia-problem.
[20]Inu Manak, Natalia Feinberg, and Gabriel Cabanas, "Amid Trade War with China, Few Industries Support the Tariffs," Council on Foreign Relations, last modified April 11, 2023, accessed September 5, 2023,
https://www.cfr.org/blog/amid-trade-war-china-few-industries-support-tariffs.
[21]Svetlicic, "FROM RED SCARE."

The process of "othering" has infiltrated into the highest echelons of policy-making, resulting in policies that shape public perceptions of China in a racialized manner. Kiron Skinner, during her tenure as the Director of Policy Planning at the US Department of State, underscored this at the security forum in Washington stating "that China posed a particularly unique challenge as it represented the first time that we will have a great power competitor that is not Caucasian." In making this assertion, she overlooks history, and fails to consider the US's confrontation with Imperial Japan during WWII. She further elaborated that "the fight with China, was a fight with a really different civilisation and a different ideology and the US hasn't had that before." American policy makers have long conflated the ideologies of the Chinese Communist Party with broader Chinese cultural identity which is indicative of the broader tendency to view China through a monolithic lens. Such generalizations not only risk marginalizing those within the Chinese diaspora who champion democratic principles, notably the denizens of Taiwan and Hong Kong, but also perpetuate the divisive narrative of "us versus them." This neglectful sentiment, deeply rooted in historical biases, has found its way into the broader public consciousness, leading to unintended consequences for the Chinese diaspora and Asian Americans at large.

The Racialized Contagion

Similar to its policy makers, American public perception of China has undergone radical change. A significant eighty-nine percent of Americans now view China as either a competitor or an "enemy." Furthermore, tangible apprehensions are escalating: sixty-three percent see China's economy as a critical threat, and over half believe the US should adopt a "tougher" stance towards China.[22] These statistics underscore the growing anti-China sentiment, much of which can be attributed to media narratives. However, a concerning trend emerges when examining the China discourse: it often veers towards inflammatory and vitriolic rhetoric. As articulated by Chang, the dominant English-language discourse on China exhibits a conspicuous void of Chinese epistemologies, underscored by the assertion that "White men maintain a disconcerting hegemony over both mainstream English-language China journalism and scholarly discourse."[23] This dialogue, deeply rooted in historiographical constructs, transcends mere racial undertones and has been calibrated to evoke the Orientalist "Yellow Peril" archetypes.

Such a trend is exemplified by headlines such as "China is the real sick man of Asia" in the Wall Street Journal,[24] which are not only insensitive to China's traumatic colonial past but

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[22] Laura Silver, Kat Devlin, and Christine Huang, "Unfavorable Views of China Reach Historic Highs in Many Countries," Pew Research Center, last modified October 6, 2020, accessed September 5, 2023, https://www.pewresearch.org/global/2020/10/06/unfavorable-views-of-china-reach-historic-highs-in-many-countries/.

[23] Enxi Chang 常恩悉, "Sinophobia, Pt. 1: The Unspoken Virus," Britain's East and South East Asian Network, accessed September 5, 2023, https://www.besean.co.uk/spotlight/sinophobia-pt-1-the-unspoken-virus.

[24] Walter Russell Mead, "China Is the Real Sick Man of Asia," Wall Street Journal, last modified February 3, 2020, accessed September 5, 2023, https://www.wsj.com/articles/china-is-the-real-sick-man-of-asia-11580773677.

also serve to perpetuate damaging stereotypes that label the Chinese as disease carriers.[25] Furthermore, during the outbreak of the pandemic news outlets like the New York Times used pictures of Chinatown and Asian people wearing masks when covering the first confirmed case of coronavirus in Manhattan even though the story was not relevant to Chinatown. Such provocative narratives not only fostered fear and distrust but also diverted attention from the actual transmission dynamics; it racialized the virus by reinforcing myths about the responsibility for the crisis. Yet, such media portrayals are nothing new; they stem from a historical phenomenon of "othering," often manifested in the attribution of disease origins and spread to marginalized or foreign groups based on perceived cultural or moral shortcomings.[26] For example, the emergence of Severe Acute Respiratory Syndrome (SARS) was most commonly linked to Chinese cultural practices deemed "unhygienic," reinforcing pre-existing stereotypes and prejudices.[27] Such narratives not only encourage social avoidance of these groups but can also catalyze more extreme forms of xenophobia and violence.

Through the racialization of the contagion, Anti-Chinese sentiment was reified into Anti-Asian violence and transformed into Sinophobia – a unwarranted fear towards East and South East Asians (ESEA). In March of 2020, the Federal Bureau of Investigation (FBI) issued an advisory concerning a surge in hate crimes against Asian Americans, attributing this uptick to societal associations between the COVID-19 virus and both China and Asian communities in the United States.[28] This phenomenon prompts an inquiry into the underlying reasons for the extension of animosity, initially directed towards China, to the broader Asian American demographic. First, it suggests that Asian Americans are often perceived as foreign, rather than as integral members of American society. This perception posits them as threats who are usurping resources and opportunities ostensibly reserved for "native" Americans. Such a viewpoint further insinuates that Asian Americans, irrespective of their place of birth, maintain allegiances to foreign nations. Second, this situation highlights the pernicious stereotype that Asian Americans are monolithic or predominantly of Chinese ancestry. This ideology exacerbates the notion that individuals of Asian descent, regardless of their specific ethnic

[25]Lijia Zhang, "Coronavirus triggers an ugly rash of racism as the old ideas of 'Yellow Peril' and 'sick man of Asia' return," South China Morning Post, last modified February 16, 2020, accessed September 5, 2023, https://www.scmp.com/comment/opinion/article/3050542/coronavirus-triggers-ugly-rash-racism-old-ideas-yellow-peril-and.

[26] Dorothy Nelkin and Sander L. Gilman, "Placing Blame for Devastating Disease," Social Research: An International Quarterly 87, no. 2 (2020): 363-378, https://doi.org/10.1353/sor.2020.0041.

[27] Lydia Kapiriri and Alison Ross, "The Politics of Disease Epidemics: A Comparative Analysis of the SARS, Zika, and Ebola Outbreaks," Global Social Welfare 7, no. 1 (2018), accessed September 5, 2023, https://doi.org/10.1007/s40609-018-0123-y.

[28]Josh Margolin, "FBI warns of potential surge in hate crimes against Asian Americans amid coronavirus," ABC News, last modified March 27, 2020, accessed September 5, 2023, https://abcnews.go.com/US/fbi-warns-potential-surge-hate-crimes-asian-americans/story?id=69831920.

origins, are diverting valuable resources from "authentic" Americans and maintain stronger ties with countries that are in competition with the United States, such as China.[29]

With the collaboration of nonpartisan and independent research entity NORC at the University of Chicago, Stop AAPI Hate, a leading advocacy organization for Asian Americans and Pacific Islanders, has compiled an extensive dossier comprising over 11,000 reported instances of hate-motivated actions, encompassing both physical assaults and racial discrimination targeting the Asian American and Pacific Islander (AAPI) demographic. Moreover, an alarming 49% of Asian Americans and Pacific Islanders across the United States have been subjected to forms of illegal discrimination or inequitable treatment.[30]

This escalation in anti-Asian violence in the United States could also be significantly attributed from a top-down level. As United Nations Secretary-General Antonio Guterres aptly describes the situation, "the pandemic continues to unleash a tsunami of hate and xenophobia, scapegoating and scare-mongering." The governmental response under the Trump administration, which saw the virus as a prime opportunity to undermine China's reputation as a means of justifying its competitive stance against the nation, not only fomented an atmosphere of hostility through inflammatory rhetoric but also employed tactics commonly used by demagogues to stoke nativist sentiments. The tendency to associate fast-spreading and lethal diseases with racial minorities and people of color has been a persistent issue, often perpetuated by white supremacist narratives that frame these groups as "viral vectors." To counteract this, the World Health Organization (WHO) made a pivotal decision to use neutral terminology for naming new pathogens, exemplified by the naming of COVID-19. However, despite WHO's guidelines, Trump publicly blamed China for the COVID-19 outbreak, through his use of the term "Chinese Virus" and "Kung-flu," which directly correlated with a 339% increase in anti-Asian hate crimes through 2021.[31] This vilification persisted even after his electoral defeat in November 2020. The consequences of this approach were twofold: it compromised the safety of Asian Americans domestically and strained diplomatic relations with China internationally.

Individuals of Asian descent have reported a disconcerting array of discriminatory behaviors directed towards them, ranging from being subjected to expectoration and coughing as a form of intimidation, to overt exclusionary practices such as being forcibly evicted from commercial establishments and being denied service by rideshare operators like Uber and Lyft.[32] Additionally, they have been victims of both verbal altercations and online harassment, as well as

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[29]Yao Li and Harvey L. Nicholson, "When 'model Minorities' Become 'yellow Peril'—Othering and the Racialization of Asian Americans in the COVID‑19 Pandemic," Sociology Compass 15, no. 2 (2021), accessed September 5, 2023, https://doi.org/10.1111/soc4.12849.

[30] "Righting Wrongs," Stop AAPI Hate, last modified May 2023, accessed September 5, 2023, https://stopaapihate.org/wp-content/uploads/2023/05/23-SAH-CivilRightsReport.pdf.

[31]Kimmy Yam, "Anti-Asian hate crimes increased 339 percent nationwide last year, report says," NBC News, last modified January 2022, accessed September 5, 2023, https://www.nbcnews.com/news/asian-america/anti-asian-hate-crimes-increased-339-percent-nationwide-last-year-repo-rcna14282.

[32]"Covid-19 Fueling Anti-Asian Racism and Xenophobia Worldwide," Human Rights Watch, accessed September 5, 2023, https://www.hrw.org/news/2020/05/12/covid-19-fueling-anti-asian-racism-and-xenophobia-worldwide.

physical assaults. This disturbing trend is further exemplified by specific incidents. In Brooklyn, New York, a female individual of Asian descent was subjected to an race-based acid attack while taking out her garbage.[33] Preceding this incident by a matter of weeks in the state of Texas, a male assailant deliberately targeted a Burmese-American individual and his two kids, aged 2 and 6, within the confines of a Sam's Club retail establishment. The perpetrator explicitly articulated his intent to exterminate the family, predicated on the erroneous assumption that they were of "Chinese and infecting people with the coronavirus."[34]

These hate crimes committed against Asians come as no surprise given the political rhetoric that has been circulating. Political figures have often amplified or initiated conspiracy theories that portray an "evil other." For instance, White House advisor Peter Navarro alleged that China had deliberately sent "hundreds of thousands" of its citizens to disseminate the virus globally.[35] In the realm of conservative media, outlets such as Fox News and the Washington Times have propagated demagogic rhetoric. These narratives have ranged from labeling the virus as the "Wuhan coronavirus" to suggesting that it is part of China's "coronavirus distraction campaign" or even insinuating its origin from a laboratory involved in China's "clandestine biological weapons program."[36] Additionally, Rush Limbaugh, a prominent conservative radio host, asserted that the coronavirus was being exploited as a tool to undermine President Trump.[37] Tragically, such demagogic rhetoric serves as a political expedient for those who wield it, advancing their anti-China agendas at the devastating cost of perpetuating suffering and discrimination against Asian Americans.

"National Security"

In the context of national security concerns, the United States is increasingly treating Chinese students and scholars as a contemporary "Yellow Peril," evoking a level of scrutiny akin to the infamous witch-hunts led by Senator Joseph McCarthy. The scapegoating began in 2018 when the Trump administration inaugurated the China Initiative, a federal program designed to scrutinize scientists of Chinese descent for purported espionage activities on behalf of the People's Republic of China. According to data from the U.S. Department of Justice (DOJ),

[33]Tina Moore and Daniel Cassady, "Brooklyn woman burned outside home in possible acid attack," New York Post, last modified April 6, 2020, accessed September 5, 2023, https://nypost.com/2020/04/06/brooklyn-woman-burned-outside-home-in-possible-acid-attack/.

[34]JuYeon Kim, "Report: Sam's Club stabbing suspect thought family was 'Chinese infecting people with coronavirus,'" KXAN, last modified April 8, 2020, accessed September 5, 2023, uptic

[35]Tom Porter, "A top White House official claimed, without evidence, that China sent sick people to other countries to 'seed' COVID-19 around the world," Business Insider, last modified May 18, 2020, accessed September 5, 2023, https://www.businessinsider.com/trump-official-navarro-accuses-china-of-plot-to-seed-coronavirus-2020-5.

[36]Bill Gertz, "Coronavirus link to China biowarfare program possible, analyst says," The Washington Times, last modified January 26, 2020, accessed September 5, 2023, https://www.washingtontimes.com/news/2020/jan/26/coronavirus-link-to-china-biowarfare-program-possi/.

[37]Gouri Sharma, "Why are there so many conspiracy theories around the coronavirus?," Aljazeera, last modified March 5, 2020, accessed September 5, 2023, https://www.aljazeera.com/news/2020/03/conspiracy-theories-coronavirus-200303170729373.html.

approximately 150 scientists were investigated under this initiative, with a staggering 90% of them being of Chinese origin.[38] The ramifications of these investigations were profound, leading to the ruination of careers, reputations, and livelihoods, often without substantive evidence to justify such actions. While, there have been genuine cases of espionage and technology transfers amongst researchers and scientists of Chinese origin working in the US,[39] the level of scrutiny and standards held by investigators were insufficient, which led to the overtly excessive reactions and baseless investigations. Gang Chen, a Professor of Mechanical Engineering at the Massachusetts Institute of Technology (MIT), encapsulated the emotional toll of this initiative, stating, "You work hard, you have good output, you build a reputation… But in the end, you're treated like a spy. That just breaks your heart. It breaks your confidence."[40] Although the Biden administration officially disbanded the China Initiative, the Department of Justice continues to examine threats from nation-states, with China still being the primary concern.[41]

Under the Biden administration the discourse about China has evolved since the initial stages of the COVID-19 pandemic, when there was a more overt connection between the virus and anti-Chinese sentiment. However, the rise in anti-Asian hate that accompanied the pandemic may continue to escalate. This is because both major political parties in the U.S. have heightened concerns about China's potential impact on American economic and national security. The tone of criticism has shifted from explicit derogatory terms to a more sophisticated vocabulary focused on national security, this rhetorical change still permits an insidious form of xenophobia to endure beneath the surface of what appears to be legitimate political discussion.

Within this status quo, the scope of U.S. criticism towards China has broadened to include a wider range of issues affecting the U.S.-China relationship, as American security officials and legislators openly address challenges such as state-sponsored cyberattacks. The Biden administration, continuing in the footsteps of its predecessor, is not only confronting China on issues of internet governance but is also renewing its focus on platforms like TikTok. This renewed focus was evident when a congressional committee subjected TikTok CEO Shou Chew to an intense five-hour questioning session about the app's connections to China via its

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[38]Jeff Sessions, "Attorney General Jeff Sessions Announces New Initiative to Combat Chinese Economic Espionage," Speech, Washington, DC United States, October 1, 2018. https://www.justice.gov/opa/speech attorney-general-jeff-sessions-announces-new-initiative-combat-chinese-economic-espionage

[39]"Survey of Chinese Espionage in the United States Since 2000," Center For Strategic International Studies, accessed September 5, 2023, https://www.csis.org/programs/strategic-technologies-program/archives/survey-chinese-espionage-united-states-2000.

[40]Ellen Barry, "'In the End, You're Treated Like a Spy,' Says M.I.T. Scientist," The New York Times, last modified January 24, 2022, accessed September 5, 2023, https://www.nytimes.com/2022/01/24/science/gang-chen-mit-china.html.

[41] Matthew Olsen, "Assistant Attorney General Matthew Olsen Delivers Remarks on Countering Nation-State Threats." Speech, Washington, DC United States, February 23, 2022. https://www.justice.gov/opa/speech/assistant-attorney-general-matthew-olsen-delivers-remarks-countering-nation-state-threats.

parent company, ByteDance. Lawmakers repeatedly insinuated that Chew, a Singaporean, was an agent of the Chinese government and attempted to link him to the Chinese Communist Party.[42]

The way some Americans discuss security risks posed by the Chinese government can be counterproductive, unnecessarily inflammatory, and historically imprecise. Labeling the situation as a "new Cold War" not only misrepresents the unique challenges presented by China but also frames the relationship in a "zero-sum" manner implying that the gain of power by one party necessarily results in the loss of power for the other. Such rhetoric perpetuates the idea that the Chinese way of life is fundamentally incompatible with that of the United States, thereby escalating tensions unnecessarily. Moreover, the terms "Chinese Communist Party" can predispose people to adopt a Cold War mindset, an analytical framework that may not be particularly useful in understanding the complexities of the U.S.-China relationship. It's important to realize that the Soviet Union was a very different competitor than China, and framing the relationship in Cold War terms can lead to poor policy choices. This confrontational rhetoric has been extended to platforms like TikTok, with calls for its ban based on the premise that the U.S. is "locked in a new Cold War with the Chinese Communist Party."[43]

Andy Kim, a New Jersey Democrat and member of the House select committee, argues that the United States should shift its focus from the legally fraught attempts to ban specific Chinese-affiliated social media companies to enacting a comprehensive national privacy law. Such a law would protect Americans' data from all prying eyes, irrespective of the company collecting it, thereby addressing the root issue of data privacy. This perspective is echoed by experts in cybersecurity who have closely examined TikTok's data collection practices. Rather than being a unique threat, TikTok serves as a mirror reflecting the broader inadequacies of U.S. privacy regulations. Pellaeon Lin, a Taiwan-based researcher affiliated with the University of Toronto's Citizen Lab, emphasizes that "TikTok is merely a byproduct of the larger surveillance capitalism ecosystem." He suggests that the government should focus on bolstering data protection laws instead of targeting individual companies without substantial evidence. As such, while policymakers remain preoccupied with the competitive dynamics involving China, they risk overlooking the broader picture that calls for comprehensive and evidence-based solutions to systemic issues like data privacy.[44]

Policy Reforms

Given the historical tendency to exaggerate fears by linearly projecting current trends without considering historical contexts or other mitigating factors, it's crucial for U.S. policy to move beyond a "zero-sum" perspective. Historically, the rise of one global power has been

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[42]Brian Fung, "Asian Americans are anxious about hate crimes. TikTok ban rhetoric isn't helping," CNN, last modified March 27, 2023, accessed September 5, 2023, https://www.cnn.com/2023/03/26/tech/asian-americans-tiktok/index.html.

[43]Marco Rubio and Mike Gallagher, "TikTok, time's up. The app should be banned in America.," The Washington Post, last modified November 10, 2022, accessed September 5, 2023, https://www.washingtonpost.com/opinions/2022/11/10/marco-rubio-ban-tiktok-america-china-mike-gallagher/.

[44]Fung, "Asian Americans," CNN.

perceived as leading to the decline of another, inevitably resulting in conflict. However, as Kupchan suggests, no single nation, including the U.S., will dominate the twenty-first century. Recognizing this shift, the U.S. should adapt itself to a transformed international system that prioritizes all states' sovereignty, and develop a toleration for different values and perspectives. Instead of striving for unilateral dominance, the U.S. should promote a multilateral world order that benefits all nations. The erosion of U.S. global leadership is not a temporary phenomenon but a lasting change to the new world order, and policy makers need to recognize this.[45]

This approach would necessitate cultivating a cooperative relationship with rising powers, notably China, by actively avoiding direct confrontations. Instead of adhering to outdated paradigms of power dynamics, it's imperative to collaboratively forge a new model for great-power relations. This model should prioritize mutual respect, understanding, and cooperation, recognizing that in today's interconnected world, collaboration yields more sustainable results than confrontation. The narrative around China needs recalibration: instead of labeling them as adversaries, they should be perceived as competitors at most. Such competition should remain centered in technological and economic domains, ensuring it doesn't devolve into cultural or racial biases. It's vital to prevent sector-specific competition from succumbing to attacks on overarching stereotypes or prejudices. By shifting the narrative from adversarial confrontation to constructive competition and potential collaboration, both nations can better serve not only their own interests but also contribute to global stability and progress. Nevertheless, the current state of affairs may seem to border on utopian thinking, given the demonstrated reluctance of both nations to engage in meaningful cooperation. Therefore, achieving this new paradigm will necessitate transformative shifts from both sides of the Pacific, not just in policy but also in mindset.

In the twenty-first century, America's chief threats arise not from any rival with the capacity to militarily threaten it, but its own internal divisions and polarization, of which racial and ethnic divisions are amongst the most important. The U.S. thus is imperiled not from external adversaries, but rather from entrenched historical narratives and imagery within its own popular culture that perpetuate pernicious stereotypes. As remarked by Jonathan Gottschall, "to get good people to behave monstrously, you must first tell them a story—a big lie, a dark conspiracy, an all-encompassing political or religious mythology."[46] The concept of the "yellow peril," akin to many stereotypes that categorically depict entire populations as malevolent, needs a revision. The origin of such narratives can be traced to a profound lack of understanding, coupled with the pervasive notion of the "other" demonstrated through the "forever foreigner" paradigm. Within western societal consciousness, Asians remain perpetually alienated,

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[45]Alexander Cooley and Daniel H. Nexon, "How Hegemony Ends The Unraveling of American Power," Foreign Affairs, last modified June 9, 2020, accessed September 5, 2023, https://www.foreignaffairs.com/articles/united-states/2020-06-09/how-hegemony-ends?check_logged_in=1&utm_m edium=promo_email&utm_source=lo_flows&utm_campaign=registered_user_welcome&utm_term=email_1&utm_ content=20230905.

[46]Jonathan Gottschall, The Story Paradox: How Our Love of Storytelling Builds Societies and Tears Them down (New York, NY: Basic Books, Hachette Book Group, 2021), 15.

irrespective of their longstanding affiliations with the nation, and will only come to harm Chinese Americans during the US's great power competition with China.

Therefore, it is imperative for the United States to diversify and reform its National security institutions. Despite comprising 7% of the eligible U.S. civilian workforce, Asian Americans are conspicuously underrepresented in the national security sector, especially in leadership positions. Asian Americans make up only 5.2% of officers and a paltry 1.8% of General Officers or Flag Officers. These statistics indicate that systemic barriers, rather than a lack of interest or motivation, are obstructing Asian Americans from career advancement in the national security sector.[47]

Epitomizing the implicit bias within the Department of State (DOS) is its "assignment restriction" policy which limits a diplomat's security clearance due to concerns about potential "targeting and harassment by foreign intelligence services" and to mitigate "foreign influence."[48] However, this policy has led to Asian Americans being disproportionately denied security clearance through assignment restrictions.[49] According to a survey conducted by the Asian American Foreign Affairs Association (AAFAA), 75% of respondents with such restrictions were not provided any rationale for these limitations. Furthermore, of those who were given justifications, nearly half identified factual inaccuracies, such as erroneous claims about family members residing in China or anachronistic references to parents born in China prior to the Communist takeover in 1949. As Lieu, a naturalized U.S. citizen born in Taipei, Taiwan, poignantly stated during a House Foreign Affairs Committee hearing in September 2020, this approach "sends the false message that people who look like me are more disloyal."[50] This opaque and flawed system not only undermines institutional trust but also perpetuates the stereotype of Asian Americans, particularly those of Chinese descent, as eternal outsiders. This raises significant concerns, especially considering that native-born Americans with Chinese heritage are statistically underrepresented in espionage activities relative to their share of the population, when compared to other demographic groups.[51]

While efforts to enhance transparency and strengthen the appeals process for assignment restrictions were initiated in 2016, these reforms were largely stymied under the Trump

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[47]"ANNUAL DEMOGRAPHIC REPORT," OFFICE OF THE DIRECTOR OF NATIONAL INTELLIGENCE, last modified 2020, accessed September 5, 2023, https://www.dni.gov/files/IC-DEI/AnnualReports/FY20_IC_Annual_Demographic_Report.pdf.

[48]"12 FAM 230 PERSONNEL SECURITY," Foreign Affairs Manual, accessed September 5, 2023, https://fam.state.gov/FAM/12FAM/12FAM0230.html#M233_5.

[49]Laura Kelly, "Asian American lawmakers say State's 'assignment restrictions' discriminate," The Hill, last modified May 11, 2021, accessed September 5, 2023, https://thehill.com/homenews/administration/552887-asian-american-lawmakers-say-states-assignment-restrictions/.

[50] Ryan Heath, "Foreigners in their own country: Asian Americans at State Department confront discrimination," POLITICO, last modified March 18, 2021, accessed September 5, 2023, https://www.politico.com/news/2021/03/18/asian-americans-state-department-477106.

[51] Cato Institute, How Much of a Threat Is Espionage From Chinese Immigrants?, last modified February 20, 2021, accessed September 5, 2023, https://www.cato.org/commentary/how-much-threat-espionage-chinese-immigrants.

Administration.[52] Nevertheless, a significant shift has occurred under the stewardship of Secretary of State Antony Blinken. This year, the State Department has now abolished its controversial policy that mandated assignment restrictions for diplomats as a condition for obtaining security clearance.[53] Although this action is commendable, it falls short of addressing the systemic issues and xenophobic tendencies that continue to plague the sector. This sentiment is echoed by a statement put forth by over 100 AAPI professionals in foreign policy and national security, which underscores the deep-rooted prejudice. They argue that the U.S.'s heightened focus on great power competition has exacerbated pre-existing prejudices, manifesting in increased suspicions, microaggressions, and overt discrimination. As they succinctly put it, "Treating all Asian-Americans working in national security with a broad stroke of suspicion, rather than seeing us as valuable contributors, is counterproductive to the greater mission of securing the homeland."[54]

Therefore, it is essential for the field of national security to prioritize diversification. The first step in this direction is to actively address the limited awareness of available career paths for candidates from diverse backgrounds. Government agencies should expand educational and recruitment initiatives aimed at students from Asian backgrounds, guiding them toward careers in national security. Furthermore, these agencies should collaborate with existing federal fellowship and scholarship programs, such as the Stokes Educational Scholarship Program offered by the NSA, to broaden their recruitment base.[55]

Concurrently, the composition of boards responsible for hiring and promotional decisions also lacks diversity, both in terms of race and gender. For instance, the Career Development Board within the Office of the Secretary of Defense (OSD) is predominantly composed of individuals from management tiers that are notably deficient in Asian American representation. To rectify this, it is imperative to diversify the cadre of decision-makers involved in the selection process for future leaders in the realm of national security. Moreover, the Defense Language and National Security Office (DLNSEO) should mandate the completion of the Regional Proficiency Assessment Tool (RPAT) for all service members. This tool aids commanders in identifying personnel with regional acumen and linguistic capabilities.[56] However, it is crucial for DLNSEO

[52]Heath, "Foreigners in their," POLITICO.

[53]Daniel Lippman, "State Department ends 'assignment restrictions' policy that some called discriminatory," POLITICO, last modified March 22, 2023, accessed September 5, 2023, https://www.politico.com/news/2023/03/22/state-ends-assignment-restrictions-policy-00088310.

[54]"Asian-Americans and Pacific Islanders in National Security Statement on Anti-Hate and Discriminatory Practices," Asian-Americans and Pacific Islanders working within National Security, accessed September 5, 2023, https://docs.google.com/forms/d/e/1FAIpQLSeiE69q4M8Jk8JcQuBFiW102zzoz2kOkYICTrY5g1x2L50fGA/viewform?fbzx=-6612651961468741654.

[55]Donna Day, "The Stokes Educational Scholarship Program (NSA)," Federal Government Jobs, last modified January 14, 2022, accessed September 5, 2023, https://federaljobs.net/blog/the-stokes-educational-scholarship-program-nsa/.

[56] Aimee Yan, "Asian American Representation is a National Security Imperative," Defense360, last modified January 28, 2022, accessed September 5, 2023, *https://defense360.csis.org/asian-american-representation-is-a-national-security-imperative/.*

to reform the RPAT to ensure that it does not unduly prioritize formal educational backgrounds over informal learning experiences and heritage-based knowledge.[57]

The implementation of these policy measures is instrumental in fostering a more diverse Department of State (DOS), thereby equipping the United States with the requisite regional and cultural acumen for engaging in "strategic empathy" in its geopolitical competition with China.[58] A diversified workforce not only enhances the nation's diplomatic capabilities but also mitigates the risk of cognitive biases such as mirror-imaging, which has historically compromised the efficacy of U.S. policy-making. Mirror-imaging is a cognitive bias where analysts, either consciously or subconsciously, filter intelligence data through their own cultural and experiential lenses. This compromises the objectivity that is crucial for sound intelligence analysis and can lead to significant distortions, forcing the data to fit into inappropriate analytical frameworks.[59] Such methodological shortcomings have been responsible for grave miscalculations in the past, as exemplified by intelligence failures that preceded pivotal national security incidents like the attacks on Pearl Harbor and the World Trade Center.[60] Consequently, fostering a diverse workforce serves as an essential countermeasure against these biases. It enables a more nuanced, multifaceted approach to China, which not only enhances diplomatic relations but also has the transformative potential to recalibrate the prevailing discourse on China from a top-down level. In effect, it moves the narrative away from racialized stereotypes, steering it towards a more nuanced, objective, and informed understanding that better captures the complexities of Sino-American interactions.

Moving Forward

As the 2024 U.S. Presidential Election looms on the horizon, the electoral landscape remains shrouded in ambiguity. At present, former President Donald Trump is emerging as the frontrunner in the Republican Primary, while President Joe Biden appears to be leading among Democratic contenders. Notably, Trump's racially charged rhetoric, which has become inextricably linked with his political persona, shows no signs of abatement. Within the broader political discourse, policymakers frequently assert that their critiques are directed at the Chinese government rather than the Chinese populace or individuals of Asian descent. However, this nuance is often relegated to a mere footnote in discussions about China, thereby failing to receive the emphasis it warrants. The lack of explicit articulation creates a vacuum in which prejudiced

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[57]Aimee Yan, "Asian American Representation is a National Security Imperative," Defense360, last modified January 28, 2022, accessed September 5, 2023,
https://defense360.csis.org/asian-american-representation-is-a-national-security-imperative/.
[58]H. R. MCMASTER, "H.R. MCMASTER ON HUBRIS, EMPATHY, AND NATIONAL SECURITY," interview, War On The Rocks, last modified December 4, 2020, accessed September 5, 2023,
https://warontherocks.com/2020/12/h-r-mcmaster-on-hubris-empathy-and-national-security/.
[59]Lauren Witlin, "Of Note: Mirror-Imaging and Its Dangers," SAIS Review of International Affairs 28, no. 1 (2008): 89-90, https://doi.org/10.1353/sais.2008.0024.
[60]William Y. Chin, "Diversity in the Age of Terror: How Racial and Ethnic Diversity in the U.S. Intelligence Community Enhances National Security," 6 Fla. A&M U. L. Rev, 2010, accessed September 5, 2023,
https://commons.law.famu.edu/cgi/viewcontent.cgi?article=1035&context=famulawreview.

interpretations can flourish. Yet, the challenge of moderating political speech becomes particularly daunting in an environment increasingly marked by polarization, where inflammatory rhetoric and demagoguery often serve as effective political strategies.

In light of the multifaceted challenges confronting us, a foundational, holistic, and enduring pedagogical strategy is critically needed. The current educational paradigm, which often leans heavily on broad-spectrum anti-racist training, has shown itself to be both ineffective and, at times, counterproductive. What is urgently required is a nuanced educational framework that not only addresses the complexities of Asian cultures but also explores their historical evolution and diverse contributions to global civilization. Educational institutions, particularly at the secondary level, should make it a priority to integrate such specialized courses into their academic programs.[61]

Additionally, a particular focus should be placed on language education, as linguistic proficiency often serves as a gateway to greater cultural understanding and open-mindedness.[62] Given the global implications of this educational challenge, international organizations such as UNESCO (United Nations Educational, Scientific and Cultural Organization) could play a pivotal role. They could develop a standardized, globally applicable curriculum that serves as a comprehensive guideline for nations across the world.

The historical landscape of global cultures has been marked by ethnocentrism, where dominant monocultural identities have sought to impose their values and norms on others. This has led to a cycle of racism and forced assimilation, perpetuating a narrow worldview. However, by adopting a more inclusive and culturally sensitive educational framework from an early age, we can disrupt this cycle. Such an approach not only diminishes prejudice within educational settings but also equips students with the tools to appreciate cultural diversity. As these students mature into adults, the benefits of this educational paradigm become even more pronounced, manifesting as reduced prejudice and greater cultural sensitivity in the workplace and society at large. Ultimately, this creates the foundation for a more globally inclusive community, one that is better equipped to navigate the complexities of an increasingly interconnected world. In the context of the United States, this approach offers a viable pathway toward racial inclusivity and serves as a model that could be emulated globally. Therefore, the onus is on educational institutions to ensure that ensuing generations perceive Asian communities, as well as all other cultures, without the veil of foreignness. In doing so, they would be fostering a transformative shift toward humanistic values that transcend the limiting and preconceived notions of today. Through steadfast commitment, both the United States and the international community stand poised to transition from a history marred by stereotypes and systemic barriers to a future built on genuine understanding, respect, and global cooperation.

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[61]Jenna S Suttmeier, "Appreciating Bilingualism: The First Step toReducing Racism in the United States," Claremont McKenna College, last modified 2011, accessed September 5, 2023, https://core.ac.uk/reader/148353180.

[62]Nadia Isa, "Learning a language opens people's minds about other cultures, expert says," ABC News Australia, last modified July 14, 2017, accessed September 5, 2023, https://www.abc.net.au/news/2017-07-15/can-learning-a-new-language-curb-racism/8709976.

Works Cited

Abbe, Allison. "Asian Americans are strategic human capital asset for national security." U.S. Army War College News Archives. Last modified May 31, 2021. Accessed September 5, 2023. https://www.armywarcollege.edu/news/Archives/13674.pdf.

Altenberg, Per. "Rising Protectionism Signals Valuable Lessons Have Been Forgotten." IISD. Last modified July 28, 2021. Accessed September 5, 2023. https://www.iisd.org/articles/rising-protectionism-signals-valuable-lessons-forgotten.

"ANNUAL DEMOGRAPHIC REPORT." OFFICE OF THE DIRECTOR OF NATIONAL INTELLIGENCE. Last modified 2020. Accessed September 5, 2023. https://www.dni.gov/files/IC-DEI/AnnualReports/FY20_IC_Annual_Demographic_Report.pdf.

"Asian-Americans and Pacific Islanders in National Security Statement on Anti-Hate and Discriminatory Practices." Asian-Americans and Pacific Islanders working within National Security. Accessed September 5, 2023. https://docs.google.com/forms/d/e/1FAIpQLSeiE69q4M8Jk8JcQuBFiW102zzoz2kOkYICTrY5g1x2L50fGA/viewform?fbzx=-6612651961468741654.

Barry, Ellen. "'In the End, You're Treated Like a Spy,' Says M.I.T. Scientist." The New York Times. Last modified January 24, 2022. Accessed September 5, 2023. https://www.nytimes.com/2022/01/24/science/gang-chen-mit-china.html.

"The Blame Game." Stop AAPI Hate. Last modified October 2022. Accessed September 5, 2023. https://stopaapihate.org/wp-content/uploads/2022/10/Stop-AAPI-Hate-Scapegoating-Report.pdf.

Brumfield, Alex. "The U.S. Has a Deep-Rooted Sinophobia Problem." International Relations Review. Last modified May 27, 2023. Accessed September 5, 2023. https://www.irreview.org/articles/the-us-has-a-deep-rooted-sinophobia-problem.

Cato Institute. How Much of a Threat Is Espionage From Chinese Immigrants? Last modified February 20, 2021. Accessed September 5, 2023. https://www.cato.org/commentary/how-much-threat-espionage-chinese-immigrants.

Chin, William Y. "Diversity in the Age of Terror: How Racial and Ethnic Diversity in the U.S. Intelligence Community Enhances National Security." *6 Fla. A&M U. L. Rev*, 2010. Accessed September 5, 2023. https://commons.law.famu.edu/cgi/viewcontent.cgi?article=1035&context=famulawreview.

Cooley, Alexander, and Daniel H. Nexon. "How Hegemony Ends The Unraveling of American Power." Foreign Affairs. Last modified June 9, 2020. Accessed September 5, 2023. https://www.foreignaffairs.com/articles/united-states/2020-06-09/how-hegemony-ends?check_logged_in=1&utm_medium=promo_email&utm_source=lo_flows&utm_campaign=registered_user_welcome&utm_term=email_1&utm_content=20230905.

"Covid-19 Fueling Anti-Asian Racism and Xenophobia Worldwide." Human Rights Watch. Accessed September 5, 2023.

https://www.hrw.org/news/2020/05/12/covid-19-fueling-anti-asian-racism-and-xenophobia-worldwide.

Day, Donna. "The Stokes Educational Scholarship Program (NSA)." Federal Government Jobs. Last modified January 14, 2022. Accessed September 5, 2023. https://federaljobs.net/blog/the-stokes-educational-scholarship-program-nsa/.

Fung, Brian. "Asian Americans are anxious about hate crimes. TikTok ban rhetoric isn't helping." CNN. Last modified March 27, 2023. Accessed September 5, 2023. https://www.cnn.com/2023/03/26/tech/asian-americans-tiktok/index.html.

Gertz, Bill. "Coronavirus link to China biowarfare program possible, analyst says." The Washington Times. Last modified January 26, 2020. Accessed September 5, 2023. https://www.washingtontimes.com/news/2020/jan/26/coronavirus-link-to-china-biowarfare-program-possi/.

Gottschall, Jonathan. *The Story Paradox: How Our Love of Storytelling Builds Societies and Tears Them down*. New York, NY: Basic Books, Hachette Book Group, 2021.

Heath, Ryan. "Foreigners in their own country: Asian Americans at State Department confront discrimination." POLITICO. Last modified March 18, 2021. Accessed September 5, 2023. https://www.politico.com/news/2021/03/18/asian-americans-state-department-477106.

Internationalist. "Global Uncertainty in an Age of 'America First.'" Council on Foreign Relations. Last modified June 28, 2017. Accessed September 5, 2023. https://www.cfr.org/blog/global-uncertainty-age-america-first.

Isa, Nadia. "Learning a language opens people's minds about other cultures, expert says." ABC News Australia. Last modified July 14, 2017. Accessed September 5, 2023. https://www.abc.net.au/news/2017-07-15/can-learning-a-new-language-curb-racism/8709976.

Kapiriri, Lydia, and Alison Ross. "The Politics of Disease Epidemics: A Comparative Analysis of the SARS, Zika, and Ebola Outbreaks." *Global Social Welfare* 7, no. 1 (2018): 33-45. Accessed September 5, 2023. https://doi.org/10.1007/s40609-018-0123-y.

Kelly, Laura. "Asian American lawmakers say State's 'assignment restrictions' discriminate." The Hill. Last modified May 11, 2021. Accessed September 5, 2023. https://thehill.com/homenews/administration/552887-asian-american-lawmakers-say-states-assignment-restrictions/.

Kim, JuYeon. "Report: Sam's Club stabbing suspect thought family was 'Chinese infecting people with coronavirus.'" KXAN. Last modified April 8, 2020. Accessed September 5, 2023. https://www.kxan.com/news/crime/report-sams-club-stabbing-suspect-thought-family-was-chinese-infecting-people-with-coronavirus/.

Li, Yao, and Harvey L. Nicholson. "When 'model Minorities' Become 'yellow Peril'—Othering and the Racialization of Asian Americans in the COVID‑19 Pandemic." *Sociology Compass* 15, no. 2 (2021). Accessed September 5, 2023. https://doi.org/10.1111/soc4.12849.

Lippman, Daniel. "State Department ends 'assignment restrictions' policy that some called discriminatory." POLITICO. Last modified March 22, 2023. Accessed September 5, 2023. https://www.politico.com/news/2023/03/22/state-ends-assignment-restrictions-policy-00088310.

Lyman, Stanford M. "The 'Yellow Peril' Mystique: Origins and Vicissitudes of a Racist Discourse." *International Journal of Politics, Culture and Society* 13, no. 4 (2000): 683-747. Accessed September 5, 2023. https://doi.org/10.1023/a:1022931309651.

Manak, Inu, Natalia Feinberg, and Gabriel Cabanas. "Amid Trade War with China, Few Industries Support the Tariffs." Council on Foreign Relations. Last modified April 11, 2023. Accessed September 5, 2023. https://www.cfr.org/blog/amid-trade-war-china-few-industries-support-tariffs.

Margolin, Josh. "FBI warns of potential surge in hate crimes against Asian Americans amid coronavirus." ABC News. Last modified March 27, 2020. Accessed September 5, 2023. https://abcnews.go.com/US/fbi-warns-potential-surge-hate-crimes-asian-americans/story?id=69831920.

MCMASTER, H. R. "H.R. MCMASTER ON HUBRIS, EMPATHY, AND NATIONAL SECURITY." Interview. War On The Rocks. Last modified December 4, 2020. Accessed September 5, 2023. https://warontherocks.com/2020/12/h-r-mcmaster-on-hubris-empathy-and-national-security/.

Mead, Walter Russell. "China Is the Real Sick Man of Asia." Wall Street Journal. Last modified February 3, 2020. Accessed September 5, 2023. https://www.wsj.com/articles/china-is-the-real-sick-man-of-asia-11580773677.

Moore, Tina, and Daniel Cassady. "Brooklyn woman burned outside home in possible acid attack." New York Post. Last modified April 6, 2020. Accessed September 5, 2023. https://nypost.com/2020/04/06/brooklyn-woman-burned-outside-home-in-possible-acid-attack/.

Nakadate, Neil, and William F. Wu. "The Yellow Peril: Chinese-Americans in American Fiction 1850-1940." *MELUS* 10, no. 3 (1983): 92-95. Accessed September 5, 2023. https://doi.org/10.2307/467445.

Nelkin, Dorothy, and Sander L. Gilman. "Placing Blame for Devastating Disease." *Social Research: An International Quarterly* 87, no. 2 (2020): 363-78. https://doi.org/10.1353/sor.2020.0041.

Olsen, Matthew. "Assistant Attorney General Matthew Olsen Delivers Remarks on Countering Nation-State Threats." Speech, Washington, DC United States, February 23, 2022. https://www.justice.gov/opa/speech/assistant-attorney-general-matthew-olsen-delivers-remarks-countering-nation-state-threats

Porter, Tom. "A top White House official claimed, without evidence, that China sent sick people to other countries to 'seed' COVID-19 around the world." Business Insider. Last modified

May 18, 2020. Accessed September 5, 2023.
https://www.businessinsider.com/trump-official-navarro-accuses-china-of-plot-to-seed-coronavirus-2020-5.

"Righting Wrongs." Stop AAPI Hate. Last modified May 2023. Accessed September 5, 2023.
https://stopaapihate.org/wp-content/uploads/2023/05/23-SAH-CivilRightsReport.pdf.

Rubio, Marco, and Mike Gallagher. "TikTok, time's up. The app should be banned in America."
The Washington Post. Last modified November 10, 2022. Accessed September 5, 2023.
https://www.washingtonpost.com/opinions/2022/11/10/marco-rubio-ban-tiktok-america-china-mike-gallagher/.

Said, Edward W. *Orientalism*. London: Penguin Books, 2003

Sessions, Jeff. "Attorney General Jeff Sessions Announces New Initiative to Combat Chinese
Economic Espionage." Speech, Washington, DC United States, October 1, 2018.
https://www.justice.gov/opa/speech/attorney-general-jeff-sessions-announces-new-initiative-combat-chinese-economic-espionage

Sharma, Gouri. "Why are there so many conspiracy theories around the coronavirus?" Aljazeera.
Last modified March 5, 2020. Accessed September 5, 2023.
https://www.aljazeera.com/news/2020/03/conspiracy-theories-coronavirus-200303170729373.html.

Silver, Laura, Kat Devlin, and Christine Huang. "Unfavorable Views of China Reach Historic
Highs in Many Countries." Pew Research Center. Last modified October 6, 2020.
Accessed September 5, 2023.
https://www.pewresearch.org/global/2020/10/06/unfavorable-views-of-china-reach-historic-highs-in-many-countries/.

"Survey of Chinese Espionage in the United States Since 2000." Center For Strategic
International Studies. Accessed September 5, 2023.
https://www.csis.org/programs/strategic-technologies-program/archives/survey-chinese-espionage-united-states-2000.

Suttmeier, Jenna S. "Appreciating Bilingualism: The First Step toReducing Racism in the United
States." Claremont McKenna College. Last modified 2011. Accessed September 5, 2023.
https://core.ac.uk/reader/148353180.

Svetlicic, Marjan. "FROM RED SCARE TO YELLOW PERIL: REALITY AND FEARS OF
THE RISE OF CHINA IN A HISTORICAL CONTEXT." *Teorija in Praksa*. Accessed
September 5, 2023.
https://www.researchgate.net/publication/347492455_Marjan_SVETLICIC_FROM_RED_SCARE_TO_YELLOW_PERIL_REALITY_AND_FEARS_OF_THE_RISE_OF_CHINA_IN_A_HISTORICAL_CONTEXT_1.

"12 FAM 230 PERSONNEL SECURITY." Foreign Affairs Manual. Accessed September 5,
2023. https://fam.state.gov/FAM/12FAM/12FAM0230.html#M233_5.

Witlin, Lauren. "Of Note: Mirror-Imaging and Its Dangers." *SAIS Review of International Affairs* 28, no. 1 (2008): 89-90. https://doi.org/10.1353/sais.2008.0024.

Yam, Kimmy. "Anti-Asian hate crimes increased 339 percent nationwide last year, report says." NBC News. Last modified January 2022. Accessed September 5, 2023. https://www.nbcnews.com/news/asian-america/anti-asian-hate-crimes-increased-339-percent-nationwide-last-year-repo-rcna14282.

Yan, Aimee. "Asian American Representation is a National Security Imperative." Defense360. Last modified January 28, 2022. Accessed September 5, 2023. https://defense360.csis.org/asian-american-representation-is-a-national-security-imperative/.

Zakaria, Fareed. "The New China Scare." Foreign Affairs. Last modified January 2020. Accessed September 5, 2023. https://www.foreignaffairs.com/articles/china/2019-12-06/new-china-scare.

Zhang, Lijia. "Coronavirus triggers an ugly rash of racism as the old ideas of 'Yellow Peril' and 'sick man of Asia' return." South China Morning Post. Last modified February 16, 2020. Accessed September 5, 2023. https://www.scmp.com/comment/opinion/article/3050542/coronavirus-triggers-ugly-rash-racism-old-ideas-yellow-peril-and.

常恩悉, Enxi Chang. "Sinophobia, Pt. 1: The Unspoken Virus." Britain's East and South East Asian Network. Accessed September 5, 2023. https://www.besean.co.uk/spotlight/sinophobia-pt-1-the-unspoken-virus.

RegTech in Kazakhstan By Aldiyar Tlebaldy

Abstract

In Kazakhstan, financial regulation is overseen by three main organizations: the Agency of the Republic of Kazakhstan for Regulation and Development of Financial Market (ARDFM RK), Astana International Financial Center (AIFC), and Financial Monitoring Agency of the Republic of Kazakhstan (FMA RK).

The ARDFM RK is charged with regulating the financial market in alignment with state policy goals, drawing from international standards established by organizations like the Basel Committee on Banking Supervision and the European Union. It fosters market growth, fair competition, and combats financial abuses.

The AIFC, with its modern infrastructure and transparent regulations, aims to become a regional Fintech hub. Its FinTech initiatives reduce traditional financial service costs, integrate with global markets, and expedite local financial system growth. The AIFC's regulatory sandbox allows firms to offer FinTech and RegTech services with reduced regulatory burdens.

The FMA RK, under the direct authority of the President of Kazakhstan, focuses on combating money laundering and terrorist financing. It oversees the prevention, detection, and investigation of economic and financial crimes in accordance with Kazakhstani legislation..

The adoption and impact of RegTech solutions

The initiatives undertaken by the Financial Monitoring Agency of the Republic of Kazakhstan, including the introduction of a Telegram bot for detecting financial pyramids, "Digital Tenge" and the implementation of the Qainar Automated Information Processing System, demonstrate a proactive approach towards enhancing financial monitoring and security in the country. The adoption of the Telegram bot has shown promising results, with over one thousand applications received by January 2023 (Kurmanova, 2023). This indicates a significant level of engagement from citizens in utilizing technology for detecting financial scams, ultimately contributing to early detection and prevention efforts. Moreover, the "Digital Kazakhstan" initiative aims to digitize both the economy and governance, with the overarching goal of reducing corruption and enhancing operational efficiency. Integral to this initiative is the deployment of RegTech solutions to streamline business processes and fortify regulatory compliance. Furthermore, the implementation of the Qainar system signifies a commitment to streamlining information security processes within the financial market. By recording security events, issuing alerts, and automating interaction on security issues, Qainar enhances the efficiency and responsiveness of monitoring efforts. The fact that all 22 banks are already connected to Qainar, with 8 utilizing automated interaction mechanisms, underscores its widespread adoption and potential impact on enhancing security within the financial sector ("Interview With..", 2021). Overall, these RegTech solutions reflect the agency's dedication to leveraging technology for effective financial monitoring and security, ultimately bolstering confidence in the integrity of Kazakhstan's financial system.

Methodology

       This research aims to investigate the current state and future prospects of RegTech (Regulatory Technology) adoption in Kazakhstan's financial industry. The study will utilize an online questionnaire distributed to two key groups: workers in the financial industry and students pursuing master's or PhD degrees in finance-related fields. The questionnaire will consist of 5 questions designed to assess participants' familiarity with RegTech, its adoption within their organizations, perceived challenges, benefits, and future outlook. A stratified random sampling method will be employed to ensure representation from both groups. Data collected will be analyzed quantitatively using statistical software to identify trends, challenges, and potential areas for improvement in the adoption of RegTech solutions. This research aims to provide valuable insights that can inform policymakers, industry practitioners, and educators about the current landscape and future trajectory of RegTech in Kazakhstan.

Questions for online questionnaire:

       1) How familiar are you with the concept of RegTech and its applications in Kazakhstan's financial industry?
- Very familiar: I have a deep understanding of RegTech and its applications in Kazakhstan's financial industry.
- Somewhat familiar: I have a basic understanding of RegTech, but I would like to learn more about its applications in Kazakhstan.
- Not familiar: I have little to no knowledge of RegTech and its applications in Kazakhstan.

2) Have you or your organization implemented any RegTech solutions in your operations?
- Yes, we have implemented RegTech solutions and have seen positive results.
- No, we have not implemented any RegTech solutions yet but are considering doing so in the future.
- No, we have not implemented any RegTech solutions and have no plans to do so in the near future.

3) What are the main challenges you face in adopting or implementing RegTech solutions in Kazakhstan?
- Lack of awareness and understanding of available RegTech solutions.
- Budget constraints and cost of implementing RegTech solutions.
- Regulatory hurdles and compliance issues.
- Integration challenges with existing systems and processes.
- Other (please specify).

4) In your opinion, what are the key benefits of integrating RegTech into Kazakhstan's financial sector?
- Improved regulatory compliance and risk management.
- Enhanced efficiency and cost savings.
- Better detection and prevention of financial crimes such as money laundering and fraud.
- Increased transparency and accountability.
- Other (please specify).

5) How do you foresee the role of RegTech evolving in Kazakhstan's financial industry in the next 5-10 years?

- RegTech will become more widespread and integral to operations in the financial industry.
- There will be increased collaboration between regulators, industry players, and RegTech providers.
- RegTech solutions will become more advanced, leveraging technologies like AI and machine learning.
- Regulators will play a more active role in promoting and regulating the use of RegTech.
- Other (please specify).

Data Analysis
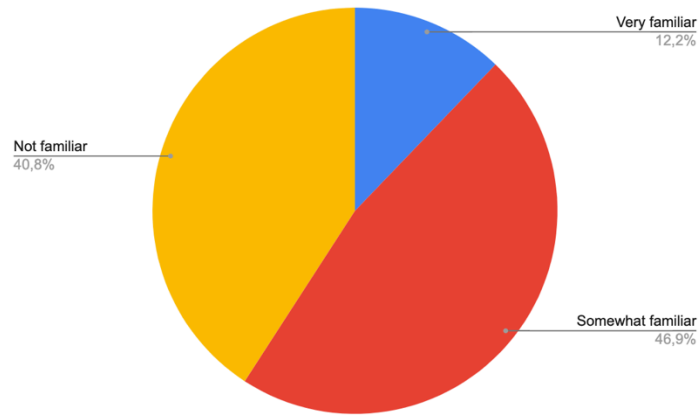
Picture 1 – How familiar are you with the concept of RegTech and its applications in Kazakhstan's financial industry?
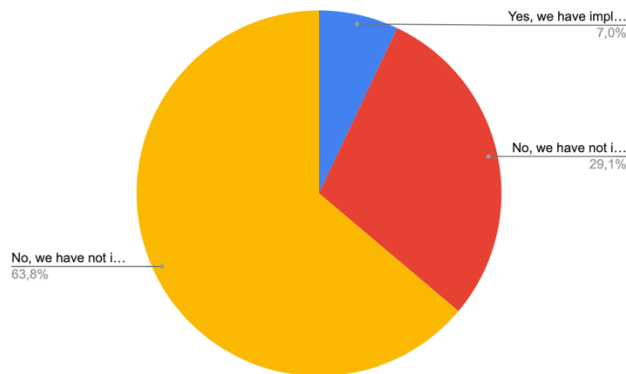
Picture 2 – Have you or your organization implemented any RegTech solutions in your operations?
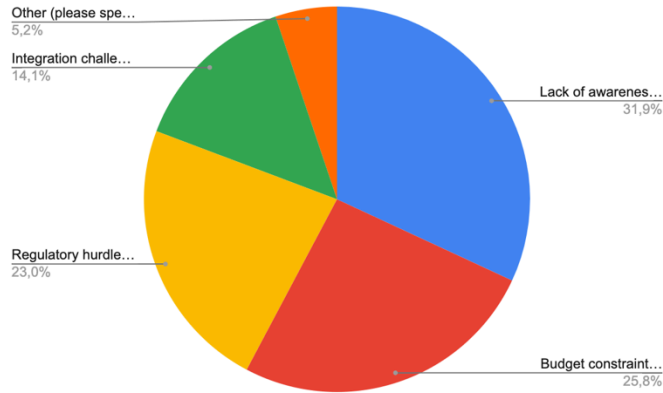
Picture 3 - What are the main challenges you face in adopting or implementing RegTech solutions in Kazakhstan?
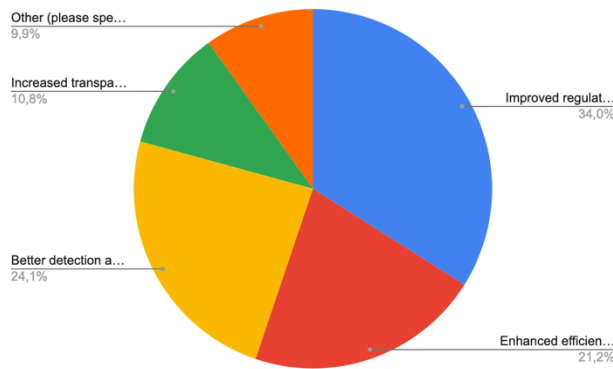
Picture 4 - In your opinion, what are the key benefits of integrating RegTech into Kazakhstan's financial sector?
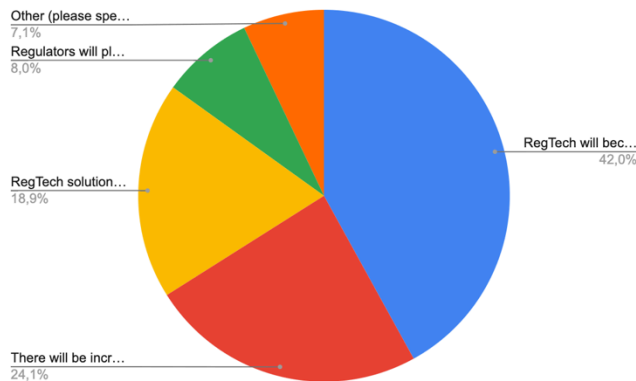
Picture 5 - How do you foresee the role of RegTech evolving in Kazakhstan's financial industry in the next 5-10 years?

Limited Awareness and Adoption:

The survey reveals a notable lack of familiarity with RegTech among respondents in Kazakhstan's financial industry. Only 12% reported being very familiar with the concept, while 47% claimed some familiarity. This suggests that a significant portion of professionals and students in the finance sector may not fully understand the potential of RegTech.

This finding is corroborated by the limited implementation of RegTech solutions reported by respondents. Only 7% indicated having implemented RegTech solutions, while a substantial 64% reported having no plans to implement them in the near future. Such low adoption rates indicate a gap between the potential benefits of RegTech and its actual utilization in Kazakhstan.

Barriers to Adoption:

The survey identified several key challenges hindering the adoption of RegTech solutions in Kazakhstan. The most commonly cited obstacles include a lack of awareness and understanding of available RegTech solutions (32%), budget constraints (26%), and regulatory hurdles (23%).

Real-world evidence supports these findings. For instance, a report by the Astana International Financial Centre (AIFC) highlights the challenges faced by Kazakhstani financial institutions in adopting advanced technologies due to limited budgets and regulatory constraints. This aligns with the survey's findings regarding budget constraints and regulatory hurdles as significant barriers to RegTech adoption.

Perceived Benefits and Future Outlook:

Despite the challenges, respondents recognize the potential benefits of integrating RegTech into Kazakhstan's financial sector. Improved regulatory compliance and risk management (34%) and better detection and prevention of financial crimes (24%) were among the key perceived benefits.

These perceptions are supported by global trends. For instance, a study by Deloitte found that RegTech solutions have proven effective in enhancing compliance efficiency and reducing operational risks for financial institutions worldwide (Murphy & Mueller, 2018). This suggests that the perceived benefits of RegTech in Kazakhstan are consistent with its demonstrated impact in other countries.

Additionally, respondents anticipate a positive evolution of RegTech in Kazakhstan's financial industry in the next 5-10 years. The expectation that RegTech will become more widespread (42%) and advanced (19%) aligns with global trends towards increased adoption and technological innovation in regulatory technology.

Overall, the survey findings underscore the current challenges and future potential of RegTech in Kazakhstan's financial sector. While awareness and adoption are currently limited, there is optimism regarding the role of RegTech in enhancing regulatory compliance, risk management, and financial integrity in the country, supported by global evidence of its effectiveness. Efforts to address barriers to adoption, such as enhancing awareness and overcoming regulatory constraints, will be essential in unlocking the full benefits of RegTech in Kazakhstan.

Conclusion

In conclusion, the research on RegTech in Kazakhstan sheds light on the current landscape, challenges, and future prospects within the country's financial sector. Our findings reveal a significant gap in awareness and adoption of RegTech solutions among professionals and students in the finance industry. Despite recognizing the potential benefits, such as improved regulatory compliance and risk management, many respondents face barriers to implementation, including budget constraints and regulatory hurdles. However, there is optimism regarding the role of RegTech in Kazakhstan's financial industry in the next 5-10 years, with expectations of increased adoption and technological advancement.

Works cited

Financial Technologies. (n.d.). AIFC. Retrieved March 15, 2024, from
https://aifc.kz/en/financial-technologies

General information. (n.d.). Financial Monitoring Agency of the Republic of Kazakhstan.
Retrieved March 15, 2024, from
https://www.gov.kz/memleket/entities/afm/about?lang=en

General information. (n.d.). The Agency for Regulation and Development of the Financial
Market of the Republic of Kazakhstan. Retrieved March 15, 2024, from
https://www.gov.kz/memleket/entities/ardfm/about?lang=en

Interview With The Head Of The Cybersecurity Department Of The Agency For Regulation
And Development Of The Financial Market Of The Republic Of Kazakhstan. (2021).
Агентство Республики Казахстан По Регулированию И Развитию Финансового
Рынка

Kurmanova. (2023). Ущерб от финпирамид в 2022 году составил 3 млрд тенге – МВД.
Деловой Портал Капитал.Кз.
https://kapital.kz/gosudarstvo/113197/ushcherb-ot-finpiramid-v-2022-godu-sostavil-3-m
lrd-tenge-mvd.html

Murphy, D., & Mueller, J. (2018). RegTech: Opportunities for more efficient and effective
regulatory supervision and compliance. Milken Institute, July 11.

A Review of Techniques to Optimize Transition Metal Chalcogenide Catalysts for Effective Photoelectrochemical Water Splitting By Anika Deshpande

Research Question: How can the surface of transition metal chalcogenides be engineered to improve heterojunction formation, defect tuning, photovoltage and photocurrent for effective water splitting?

Abstract

Water splitting is a hydrogen generation process that uses sunlight to separate water into its components: hydrogen and oxygen. This process takes place when a photoelectrode produces electrons from sunlight in the presence of an electrolyte solution. These electrons engage in the oxygen evolution reaction (OER) at the anode, leading to the generation of oxygen gas. Simultaneously, positively charged holes (vacancies in the electron structure) partake in the hydrogen evolution reaction (HER) at the cathode, resulting in the production of hydrogen gas. While this process elicits appeal due its sustainable nature, it is premature for industrial synthesis due to the instability, cost inefficiency, and unscalable nature of the current catalysts used.

Therefore, this research examines a class of earth-abundant and cost-effective semiconductor materials known as transition metal chalcogenides (TMCs) that could potentially serve as alternative catalysts to the current ones. Through an analysis of surface engineering techniques for champion materials in the field, a relationship between a chosen material and an optimization technique is found, leading to the establishment of Sb_2Se_3 as a superior catalyst and sulfur richness as the best optimization technique for it. In addition to highlighting the untapped potential of TMC's, this research also lays out prospects for future research to rectify knowledge gaps about solution environment and long-term effects of electrolysis within the field. Systematic experiments involving finding the impact of pH, solution composition, and ionic strength on semiconductor and catalyst behavior in water splitting, aim to optimize their performance. Additionally, addressing the challenge of defects during prolonged electrolysis, a multifaceted approach includes in-situ characterization, accelerated aging experiments, and computational modeling.

1. Introduction

The onset of global warming urgently requires clean and cost-effective energy resources to replace traditional fossil fuels. Hydrogen, distinguished by its high gravimetric energy density and carbon-free chemical composition, has emerged as a preferred clean energy option. Leveraging hydrogen to reform the energy supply structure of every aspect of our society is believed to be the most promising way to achieve zero carbon by 2050. Currently, steam reforming of fossil fuel is the prevalent process to produce hydrogen for industry, which inevitably emits CO_2 due to both the stoichiometry of the reaction and the fossil fuel combustion required for heat supply. One of the ideal ways to avoid these CO_2 emissions in hydrogen production is electrochemical water splitting driven by renewable energy sources like solar light.

Solar light-assisted photoelectrochemical (PEC) water splitting is a process that uses sunlight to directly dissociate water into hydrogen and oxygen. The process involves a photoelectrode absorbing sunlight to generate electrons, coupled with an electrolyte solution. The electrons participate in the oxygen evolution reaction (OER) at the anode, resulting in the production of oxygen gas, while positively charged holes (vacancies in the electron structure) contribute to the hydrogen evolution reaction (HER) at the cathode, yielding hydrogen gas. The appeal of water splitting lies in its sustainable nature for hydrogen generation.

While solar light-assisted PEC water splitting stands out as a highly efficient approach to produce hydrogen and oxygen, it remains insufficient in industrial applications because of the inherent instability of catalysts that drive the reaction. As found in *Recent Advances in Noble Metal-Based Electrocatalysts for Efficient Hydrogen Evolution Reaction,* Precious metals, notably platinum (Pt), iridium (Ir), ruthenium (Ru), and their alloys, have been recognized as optimal electrocatalysts due to their exceptional activity and stability for water splitting (Changqing Li and Jong-Beom Baek). However, the limited availability and high cost of these precious metals impose significant constraints on their widespread practical use at an industrial scale. Consequently, the quest for economically viable and sustainable alternatives to these precious metal catalysts has become imperative for the advancement of solar-driven PEC water splitting technologies in real-world applications. Substantial research endeavors have thus been directed towards increasing the conversion efficiency of these electrocatalysts, as evidenced by the abundance of publications in this field.

One way to achieve this is *via* advancing the design of highly efficient, scalable, and stable materials tailored to effectively catalyze PEC water splitting reactions. In particular, transition metal chalcogenides (TMCs) are a class of compounds featuring transition metals bonded with chalcogen elements, exhibiting semiconductor properties with layered structures. These materials offer a cost-effective and Earth-abundant alternative to the currently employed precious metals, as their structural versatility makes them promising electrocatalysts for water splitting. TMCs efficiently absorb and activate water molecules, making them potential catalysts for both the Oxygen Evolution Reaction (OER) and the Hydrogen Evolution Reaction (HER). Moreover, they demonstrate remarkable stability, maintaining catalytic activity and structural integrity even under the harsh conditions inherent in the water splitting process. Their highly crystalline structures also contribute to well-defined electronic band structures, resulting in heightened electrical conductivity.

2. Proposal

Because transition metal chalcogenides are semiconductors, their photocurrent density is intricately shaped by crystal size, morphology, and orientation, leading to superior photocurrent characteristics. Specifically, the presence of heteroatoms within their crystal structures allows for effective doping, enabling substantial alterations in electronic properties. This doping can tune parameters such as bandgap, thereby optimizing electric conductivity and catalytic activity, but is relatively unexplored. Additionally, defect engineering is possible for these materials, which

benefits both intrinsic catalytic activity and electric conductivity. Despite this, it remains challenging to further improve the electrocatalytic activity and long-term stability of TMCs, especially in a practical water electrolyzer. However, TMCs can be readily synthesized as nanocrystals. In addition to the increased surface area that comes with smaller size, it has been shown that different synthetic techniques can alter the morphologies/surfaces of these nanomaterials. For example, in *Exfoliated Molybdenum Disulfide-Wrapped CdS Nanoparticles as a Nano-Heterojunction for Photo-Electrochemical Water by Sukdev Dolai, Pradip Maiti, and colleagues,* liquid phase exfoliation using chemical vapor reaction (CVR) with chalcogen powders was used to synthesize TMCs with more exposed surface active sites, which enhanced intrinsic high electrocatalytic activity for both HER and OER.

In this research paper, with the help of my research mentor, I will analyze how engineering the surface of nanosized transition metal chalcogenides leads to improved catalytic activity with regards to PEC water splitting. I will then propose an optimal route to achieve a viable TMC electrocatalyst.

3. Background

Looking at the current state of the field, it is important to assess the champion materials for electrochemical water splitting, as it often provides important insight for future research and optimization. As aforementioned, TMCs show great promise as next generation catalysts for electrochemical water splitting due to their noteworthy electrocatalytic capabilities and distinctive features, in addition to their environmental and economic benefits. This section will assess the current champion TMC materials.

First, Sb_2Se_3, a layer-structured semiconductor with an orthorhombic base, is considered one of the leading TMCs for water splitting. Sb_3Se_2 exhibits unique atomic arrangements where each Sb and Se atom is surrounded by three opposing atoms. The antimony atoms, specifically, form a trigonal pyramidal coordination with the surrounding selenium atoms. The crystal lattice showcases layered structures held together by weak van der Waals interactions between the layers, rendering it as a heterojunction catalyst. Notably, Sb_2Se_3 has earned the recognition as a benchmark material due to its remarkable achievement of one of the highest photocurrent densities-30 mA cm-2 at 1 vs Ag/AgCl electrode, as found by Mohsin Ali Marwat, Muhammed Humayan, and others, in *Advanced Catalysts for Photoelectrical Water Splitting*—under simulated light.

The exceptional photocurrent density can be attributed to the efficient charge transport facilitated by well-ordered vertical [001] nanowires of Sb_2Se_3, a component of Sb_2Se_3. Moreover, the direct bandgap resulting from its layered structure ensures that electrons and holes, generated by absorbed photons, exhibit high mobility. This characteristic allows them to contribute to the photocurrent without requiring additional energy to reach the band extrema, a quality which is highly desirable in water splitting. The strong anisotropy of Sb_2Se_3 becomes evident as it demonstrates greater mobility in the [001] direction compared to [010] and [100] (Marwat *et al.*

12023). The high mobility and anisotropic characteristics of Sb$_2$ allows for directional control of reaction pathways, which can enhance the overall efficiency of the water splitting process.

The optimization of Sb$_2$Se$_3$ photocathodes involves experimenting with various solvent combinations. Marwat and Humayan used 2-mercaptoethanol and ethylenediamine. By manipulating the proportion of selenium to antimony precursor, enhanced photocurrents were achieved. The resulting Sb$_2$Se$_3$ material displayed a "compact film-like shape" (Marwat *et al.* 12023) oriented along [001], revealing a high density of photocurrent. This multifaceted approach not only shows the material's unique properties but also shows the potential for advancing the practical applications of water splitting.

Another promising material is Pyrite NiS$_2$, which crystallizes in the hexagonal space group. A noteworthy feature of NiS$_2$ is its ability to undergo electronic structure reconfiguration, transitioning from typical semiconductive characteristics to metallic characteristics through the introduction of vanadium (V) displacement defects, as described in *A Mini Review on Transition Metal Chalcogenides for Electrocatalytic Water Splitting: Bridging Material Design and Practical Application by Yongjie Liu, Yajie Guo, and others,* Experimental temperature-dependent resistivity and theoretical density functional theory calculations have confirmed this transformation. Elaborate X-ray absorption spectroscopy measurements further elucidate that the reconfiguration of NiS$_2$'s electronic structure is rooted in electron transfer from doped V to Ni sites, making Ni sites electron rich. (Liu et al 2617)

This unique characteristic makes Pyrite NiS2 particularly suitable for water splitting. The metallic V-doped NiS$_2$ nanosheets have emerged as one of the most promising non-noble-metal bifunctional electrocatalysts. As observed in *A Mini Review on Transition Metal Chalcogenides for Electrocatalytic Water Splitting: Bridging Material Design and Practical Application*, these nanosheets exhibit exceptional electrocatalytic activity, displaying overpotentials of approximately 290 mV for OER at 10 mA cm − 2 in a 1 M KOH solution. (2617) The effectiveness of Pyrite NiS$_2$ in water splitting is due to the shift in its electronic structure from semiconductive to metallic. This transition has been substantiated by both temperature-dependent resistivity experiments and theoretical calculations, highlighting the material's enhanced conductivity and electrocatalytic performance in facilitating the crucial OER step during water splitting processes.

NiSe is another material that is suitable for water splitting. The significance of NiSe in water splitting arises from its exceptional performance in the HER when compared to other Ni-based (oxy)hydroxides and selenides. The distinctive hexagonal crystalline structure, inherited from the precursor Ni(OH)2 nanosheets supported on nickel foam (Fig 1), serves a dual purpose. As found in *A Mini Review on Transition Metal Chalcogenides for Electrocatalytic Water Splitting: Bridging Material Design and Practical Application* by Yongjie Liu, Yajie Guo, and others, , these prefabricated nanosheets facilitate the transformation of ultrathin 2D non-layer Nise through selenization, acting as both the nickel ion source and the skeleton template.
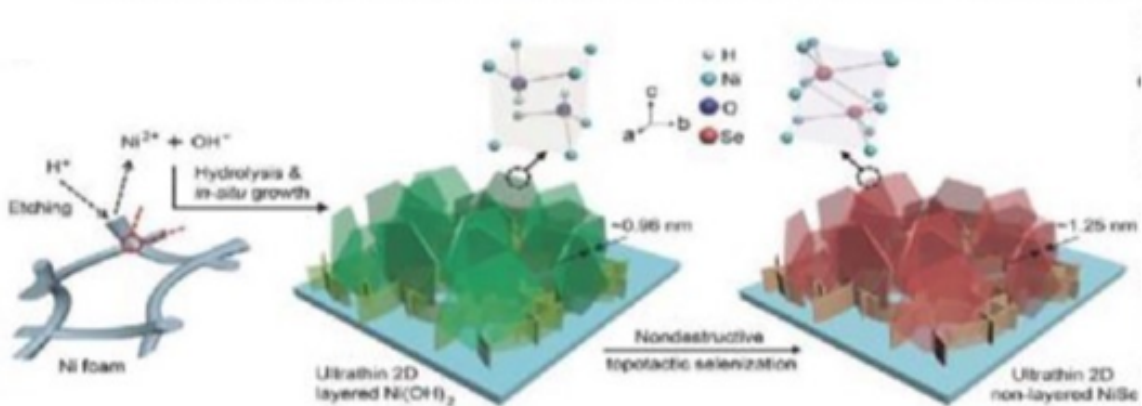
Fig 1: This figure shows prefabricated Ni(OH)$_2$ nanosheets supported on nickel foam. Engineered nanosheets play a dual role, acting as both a source of nickel ions and a template. They guide the formation of NiSe on nickel foam, creating a durable hexagonal structure that facilitates overall efficiency in water splitting by sustaining catalytic activity. (Liu *et al.* 2612)

The resulting NiSe, maintaining the morphology of the Ni(OH)$_2$ precursor, emerges as a catalyst with superior electrocatalytic activity for the HER. The existence of large cavities in its structure, coupled with the weak bonding force, contributes to the overall efficacy of the NiSe in promoting hydrogen evolution. Additionally, the hybrid catalysts formed during this process often display distinct interfacial effects and synergetic effects, further enhancing their electrocatalytic performance. In essence, NiSe, derived from a well-designed precursor, stands out as a promising semiconductor material, showcasing remarkable activity and structural characteristics that contribute to efficient hydrogen evolution.

Finally, the semiconductor material CZTS-Ag$_2$S possesses distinctive characteristics in both surface chemistry and crystal structure that contribute to its efficacy in water splitting applications. as found in *Cu2ZnSnS4−Ag2S Nanoscale p−n Heterostructures as Sensitizers for Photoelectrochemical Water Splitting* by Xuelian Ju, Jingjing Liu, and others, the Ag$_2$S nanocrystals within the CZTS-Ag$_2$S configuration examined at the [311] axis exhibit a quasi-spherical geometry, with an average particle size of 12 nm. The crystal structure of Ag$_2$S nanocrystals within the CZTS-Ag$_2$S configuration exhibit a quasi-spherical geometry, with an average particle size of 12 nm. The crystal structure of Ag2S, with its monodisperse morphology, is characterized by lattice parameters of a = 0.4127 nm, b = 0.6699 nm, and c = 0.7838 nm, with space-group symmetry P21/c, $\alpha = \gamma = 90°$, and $\beta = 99.67°$. Simultaneously, the power spectrum of CZTS nanocrystals displays wurtzite-phase when examined at the [11-2-3] axis, featuring lattice parameters of a = b = 0.3839 nm and c = 0.6339 nm, with a space-group symmetry of P63mc (Ju *et al.* 10558).

The effectiveness of CZTS-Ag$_2$S for water splitting is attributed to its p-n heterostructure, which serves as a sensitizer to enhance the photocurrent response in PEC water splitting. The

designed CZTS-Ag2S p-n heterojunction catalysts form a type-II band alignment, facilitating charge separation and thereby improving the PEC performance of the heterostructure. Notably, the TiO2/CZTS-AG$_2$S heterostructure catalyst (H2 sample) demonstrates superior performance, exhibiting a photocurrent density of 0.15 mA cm-2 at 0.5 V. As seen in Fig 2, this performance surpasses that of TiO2 (0.03 mA cm-2) and TiO2/CZTS (0.06 mA cm-2) (Ju *et al.* 10558), confirming the enhanced PEC performance under visible light irradiation.
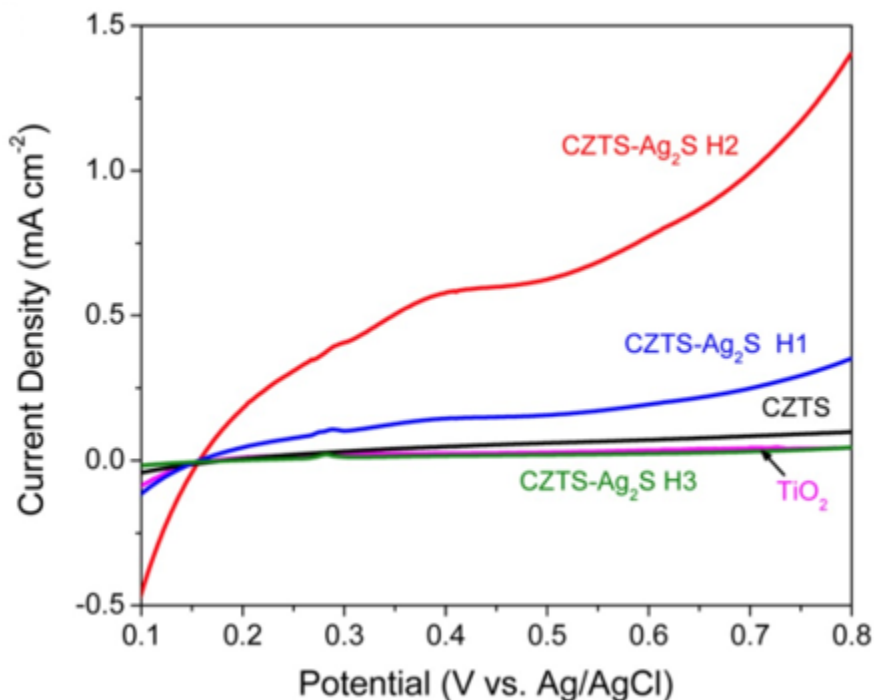
Fig 2: This figure captures the exceptional performance of CZTS-AG$_2$S attributed to a robust p-n heterostructure, especially TiO2/CZTS-AG$_2$S (H2) which surpasses traditional counterparts under visible light.

4. Methods/Materials

Transitioning from the examination of the champion TMCs, we must explore optimization strategies for these semiconductor materials, to achieve increased PEC activity and overall efficiency of the water splitting process:

First, composite materials can increase PEC activity because the addition of nanoparticles with desirable characteristics can optimize the effectiveness of the composite material as a whole. In *Exfoliated Molybdenum Disulfide-Wrapped CdS Nanoparticles as a Nano-Heterojunction for Photo-Electrochemical Water Splitting*, Sukdev Dolai, Pradip Maiti, and others found that by wrapping CdS nanoparticles by few layer MoS2, the absorption spectra in the visible range of the CdS particles would increase the absorption coefficient of MoS2@CdS composites, enhancing PEC performance as seen in Fig 3.
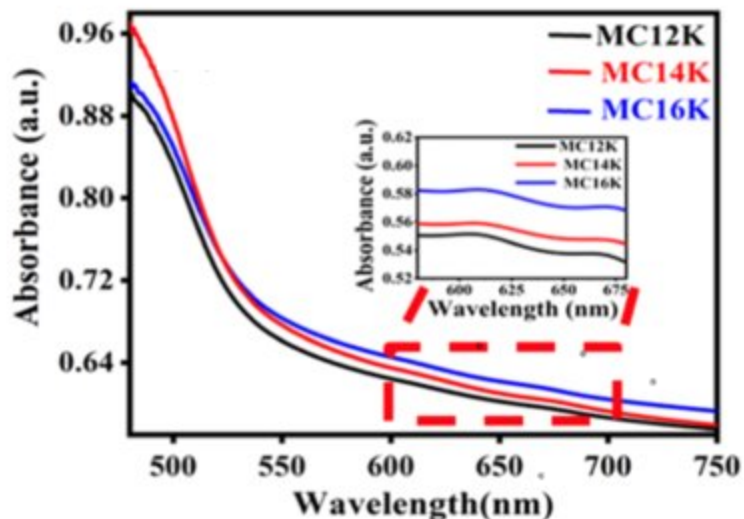
Fig 3: This figure shows CdS nanoparticles wrapped with a few layers of MoS2. The absorption spectra in the visible range are increased, enhancing the effectiveness of MoS2@CdS composites by maximizing photon capture to improve overall PEC performance (Dolai *et al.* 441).

Similar to the CdS nanoparticles, janus particles can also facilitate efficient light absorption. In addition, they improve charge carrier separation, and allow for customization of semiconductors due to their dual functionality. This dual functionality allows for tailored interactions with different materials and environments. In *Janus WSSe Monolayer: An Excellent Photocatalyst for Overall Water Splitting* by Lin Ju, Mei Bie, etc,, strain engineering (application of both compression and tensile strains) was used to optimize the optical absorption of the Janus WSSe monolayer. The external tensile strains were found to increase the solar-to-hydrogen energy conversion efficiency by pushing the electrons (holes) to the Se (S) layer by the built-in polarization field, which resulted in the lower binding energy of excitons. (Fig 4) Therefore, the charge carrier separation of photoexcited electrons and holes is improved along with the photocatalytic efficiency. (Figs 5 and 6)
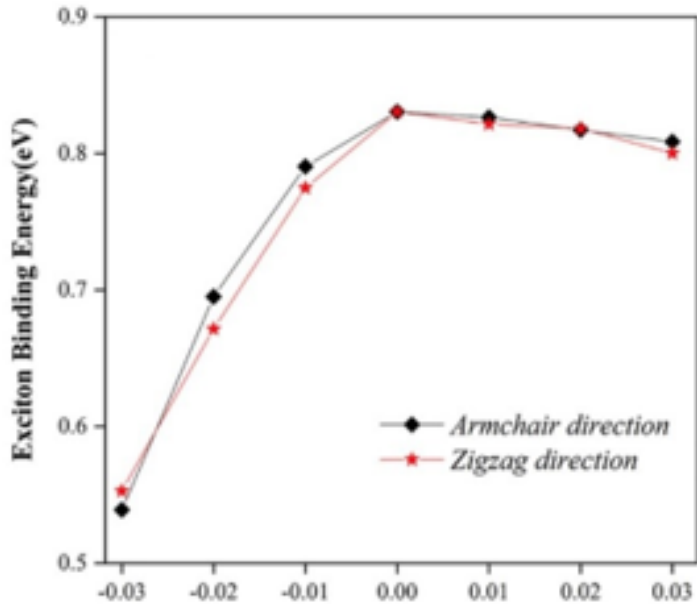
Fig 4: This figure illustrates the impact of strain engineering on the Janus WSSe monolayer. External tensile strains optimize the binding energy of excitons (electron-hole pairs), boosting the separation of photoexcited electrons and holes for improved photocatalytic efficiency. (Ju *et al.* 29337)
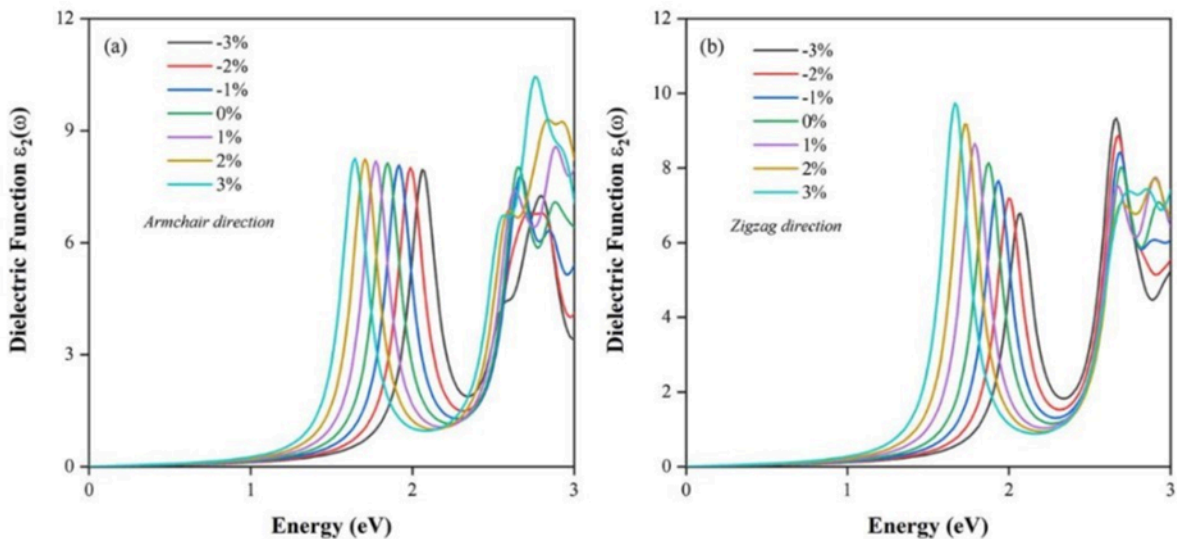
Fig 5: This figure shows the improved dielectric properties of WSSe monolayers, a key factor in optimizing their performance for water splitting. These properties contribute to the overall efficiency of Janus WSSe monolayers in separating photoexcited electrons and holes, crucial for successful water splitting processes. (Ju *et al.* S3)
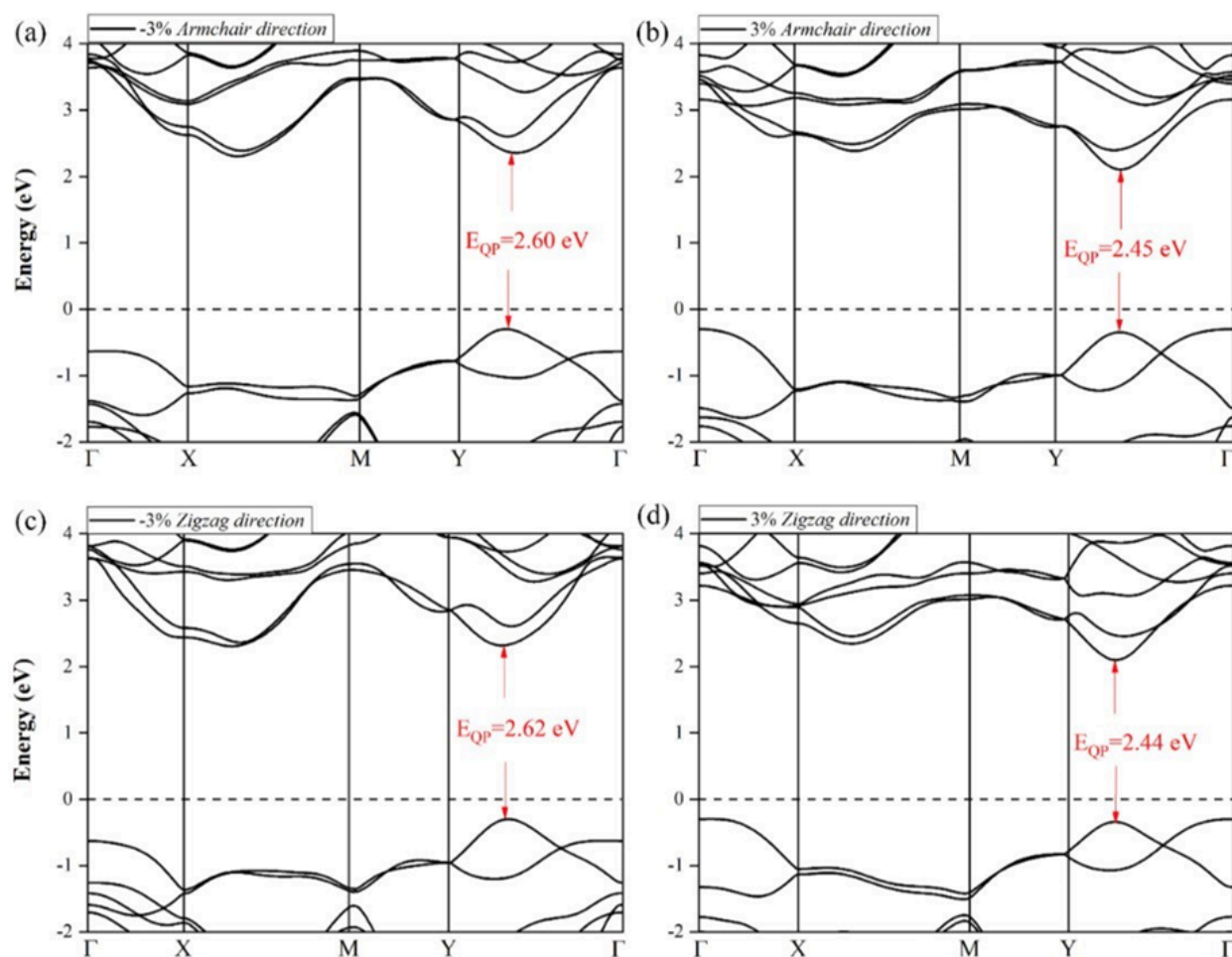
Fig 6: This figure displays band structures of strained monolayers in different directions. The indicated values show how applying strain can adjust the bandgap, critical for better separating charged particles. This characteristic improves the efficiency of WSSe monolayers in splitting water for clean energy. (Ju *et al. S4*)

Another optimization technique involves sulfur vacancies. Sulfur vacancies can introduce defect states within the crystal lattice. Properly engineered vacancies can facilitate efficient charge separation, enhancing the mobility of charge carriers. For example, 2D rhombohedral $ZnIn_2S_4$ with rich sulfur vacancies has effective electron-hole separation efficiency which, coupled with its crystal phase, improves overall water splitting performance. In fact, the solar-to-hydrogen conversion efficiency of sulfur vacancy-enriched rhombohedral $ZnIn_2S_4$ reaches the highest reported efficiency for single-phase $ZnIn_2S_4$, as found in *Sulfur Vacancy-Enriched Rhombohedral $ZnIn_2S_4$ Nanosheets for Highly Efficient Photocatalytic Overall Water Splitting under Visible Light Irradiation* by Haitong Jing, Gao Xu, and others As seen in Fig 7, the photocurrent spikes of $ZnIn_2S_4$-800 show that the holes gathered at the electrode/electrolyte interface cannot move to the electrolyte quickly. The correlation between

this and the surface states indicates that the sulfur vacancies and the crystal phase collaboratively boost the carrier concentration.
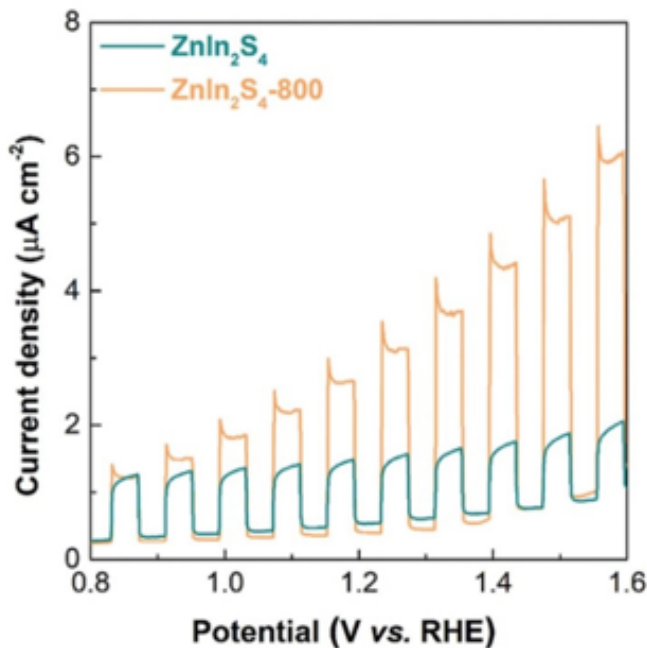
Fig 7: This figure shows spikes in photocurrent for $ZnIn_2S_4$-800, showcasing optimized carrier concentration through the collaboration of sulfur vacancies and crystal phase. This is crucial for improving the efficiency of water splitting, where more carriers mean better energy conversion. (Jing *et al.* 10192)

Finally, sulfur richness can tune the bandgap by influencing quantum confinement effects. Narrowing the bandgap improves PEC performance as it aids in the absorption of a broad spectrum of solar energy. Bandgap narrowing may be accomplished by integrating a donor-acceptor into the semiconductor. ~1.6−2.2 eV is the optimal band gap for effective PEC water splitting. Within this band gap range, the band edge location is precise, and the photo charge carrier mobility is increased. For example, in the work done by Torben Daeneke, Nripen Dahr, and colleagues, in *Surface Water Dependent Properties of Sulfur-Rich Molybdenum Sulfides: Electrolyteless Gas Phase Water Splitting*, sulfur rich MoS features a narrow band gap which shows high conductivity. This enables its outstanding performance as an electrocatalyst. Each of the materials presented above have their own merits when it comes to water splitting applications. However, considering the emphasis on photocurrent density and efficiency in photoelectrochemical water splitting, Sb_2Se_3 stands out as the most promising material. It demonstrates exceptional photocurrent density, attributed to well-ordered vertical nanowires of Sb_2Se_3 and the direct bandgap resulting from its layered structure. The anisotropic characteristics of Sb_2Se_3 also allow for directional control of reaction pathways, enhancing overall efficiency. While Pyrite NiS2, NiSe, and CZTS-Ag_2S exhibit interesting properties, which could increase the efficacy of some aspect of the water splitting process, Sb_2Se_3's superior photocurrent density

and efficient charge transport make it a robust candidate for optimizing catalytic activity in photoelectrochemical water splitting.

To optimize Sb_2Se_3, sulfur richness stands out as the most promising optimization method in photoelectrochemical water splitting due to its ability to tune the bandgap and influence quantum confinement effects. The layered structure of Sb_2Se_3, characterized by well-ordered vertical nanowires of Sb_2Se_3, makes bandgap tuning through sulfur richness highly relevant, enabling the material to efficiently absorb a broad spectrum of solar energy. This method aligns with the emphasis on achieving high photocurrent density, a notable strength of Sb_2Se_3, by enhancing the absorption coefficient. Additionally, sulfur vacancies, associated with this approach, introduce defect states that facilitate efficient charge separation, further contributing to enhanced charge carrier mobility. The chosen optimization strategy complements the inherent characteristics of Sb_2Se_3, making sulfur richness the most suitable method to maximize the efficiency of the water splitting process.

While sulfur enriched Sb_2Se_3 remains the premier material and method combination for optimizing electrocatalysts in water splitting, it is worth acknowledging that alternative materials mentioned above, when subjected to methods tailored to their specific characteristics, can also pose competitive solutions.

For example, Pyrite NiS_2, with its ability to transition from semiconductive to metallic characteristics through vanadium (V) displacement defects, suggests that optimizing charge carrier separation and mobility could significantly enhance its electrocatalytic activity for water splitting. Introducing sulfur vacancies can strategically induce defect states within the crystal lattice, creating favorable conditions for efficient charge separation. The defect-rich environment can facilitate the mobility of charge carriers, improving overall electrocatalytic performance. Sulfur vacancies may enhance the catalytic sites, promoting the oxygen evolution reaction (OER) efficiency crucial for water splitting. This optimization aligns well with Pyrite NiS_2's unique electronic structure and metallic properties, aiming to enhance its electrocatalytic activity for efficient water splitting.

$CZTS-Ag_2S$, with its p-n heterostructure serving as a sensitizer for enhanced photocurrent response, could benefit significantly from the introduction of composite materials. Composite materials, formed by incorporating nanoparticles with desirable characteristics, can optimize the overall effectiveness of the $CZTS-Ag_2S$ heterojunction catalyst. The addition of nanoparticles could enhance charge transport, boost light absorption, and facilitate efficient charge separation, thereby improving the photoelectrochemical (PEC) performance. By carefully selecting nanoparticles that complement the properties of $CZTS-Ag_2S$, such as those with suitable band alignments, the composite material can contribute to achieving a higher photocurrent density and overall efficiency in the water splitting process. This optimization strategy aligns with $CZTS-Ag_2S$ heterostructure design, aiming to maximize its PEC activity through synergistic effects with composite materials.

Summatively, the choice of optimization techniques for semiconductor materials in photoelectrochemical water splitting depends on the unique characteristics of each material.

Tailoring the optimization methods to align with the material's inherent properties is crucial for achieving enhanced performance. For instance, sulfur richness emerges as a highly effective optimization technique for Sb_3Se_2 due to its ability to tune the bandgap and influence quantum confinement effects, complementing the layered structure and emphasizing the material's strength in achieving high photocurrent density. Similarly, for Pyrite NiS_2, sulfur vacancies are deemed optimal as they capitalize on the material's transition from semiconductive to metallic states through vanadium displacement enhancing the charge carrier separation and mobility. On the other hand, composite materials are identified as a preferred optimization strategy for CZTS-Ag_2S, leveraging its p-n heterostructure to improve charge transport and light absorption. This tailored approach ensures that each material's specific characteristics are synergistically enhanced, providing a targeted and effective means to optimize their catalytic activity for photoelectrochemical water splitting.

5. Conclusions/Future Directions

Optimizing the performance of TMCs in water splitting rests significantly on tuning their surface characteristics. This imperative is exemplified through the strategic introduction of vacancies, composite materials, Janus particles, and sulfur-rich configurations. These surface engineering techniques play a pivotal role in enhancing the overall efficiency of TMCs by contributing to improved charge separation, heightened light absorption capabilities, and the tailoring of band structures. The synergistic impact of these modifications results in superior photocatalytic and photoelectrochemical activities. The thorough comprehension of these surface-tuning methods not only sheds light on the fundamental mechanisms governing TMC behavior but also lays a strong foundation for the advancement of their practical applications in the critical domain of water splitting.

Despite this strong foundation however, challenges still remain in the field of water splitting: first, the limited understanding of environmental factors' influences on the energetics and stability of semiconductors, as well as the properties of catalysts in photoelectrochemical water splitting, (Marwat et al. 12024) poses obstacles to the advancement of this crucial renewable energy technology. The optimization of water-splitting systems is inherently tied to the intricate interplay between semiconductor materials, solution environment, and catalysts. Without a comprehensive grasp of how factors like pH, solution composition, and ionic strength impact these components, researchers face challenges in developing efficient and stable systems.

The rectification of this knowledge gap is crucial for several reasons. Firstly, the efficiency of photoelectrochemical water splitting is directly correlated with the electrochemical behavior of semiconductors and catalysts. A nuanced understanding of how environmental factors influence these components is essential for tailoring materials and conditions to maximize performance. Without this knowledge, the full potential of PEC water splitting as a sustainable and viable method for hydrogen production remains unrealized. Secondly, the stability of the components over prolonged usage is a critical concern for practical applications. Incomplete knowledge of the impact of environmental variables can lead to accelerated degradation,

reducing the overall lifespan of water splitting systems. Addressing this limitation is imperative for the development of durable and economically viable technologies that can be implemented on a large scale. Finally, closing this knowledge gap is essential for guiding future research innovation in the field. A thorough understanding of the complex relationships between environmental factors and semiconductor-catalyst systems will pave the way for targeted improvements and the development of novel materials. This, in turn, will contribute to overcoming the current limitations and advancing the broader goal of harnessing solar energy for sustainable hydrogen production.

To address this knowledge gap, a series of systematic experiments can be designed. Firstly, experiments can be designed to investigate the influence of solution composition. This entails altering the composition of the electrolyte solution by introducing different ions or adjusting the concentrations of existing ones. The subsequent effects on semiconductor behavior and catalyst properties can then be analyzed. For example, the impact of pH variations on the semiconductor/s energetics and stability can be assessed by conducting PEC measurements under controlled pH conditions. This involves systematically varying the pH of the electrolyte solution and monitoring the resulting changes in the semiconductor's performance. Similarly, the role of ionic strength can be explored by varying the concentration of electrolytes in the solution. This is crucial as the presence and concentration of ions can significantly impact the electrochemical behavior of the semiconductor and catalyst.

These experiments collectively aim to elucidate the impact of pH, solution composition, and ionic strength, allowing researchers to contribute to valuable insights towards optimizing the performance and stability of semiconductors and catalysts in this critical renewable energy process. Not only will this facilitate the optimization of current systems but will also provide a foundation for the development of next-generation materials and methodologies, bringing us closer to a sustainable and efficient future for hydrogen production.

Another challenge is that the evolution of vacancies and defects in materials, particularly their impact on outstanding electrocatalytic activities during long-term electrolysis in water splitting, remains a widely unknown aspect in the field of renewable energy research (Liu et al. 2623). Vacancies and defects play a pivotal role in determining the catalytic performance of materials, influencing their electronic structure, reactivity, and stability. In the context of prolonged electrolysis for water splitting, the lack of understanding regarding the dynamic behavior of these defects poses a significant problem.

The electrocatalytic activities of materials can be highly dependent on the presence and distribution of vacancies and defects. Over extended periods of electrolysis, the evolution of these imperfections could lead to changes in the material's catalytic efficiency, potentially resulting in reduced performance or even degradation. This lack of knowledge poses a considerable obstacle to the development of durable and efficient water splitting technologies for large scale applications.

Addressing this issue requires a multifaceted research approach. One potential avenue is the development of in-situ characterization techniques that can monitor the evolution of

vacancies and defects in real-time during electrolysis. Advanced imaging and spectroscopic methods, such as in-situ transmission electron microscopy (TEM) or operando X-ray absorption spectroscopy, could provide insights into the structural changes occurring at the atomic level.

Additionally, controlled accelerated aging experiments can be designed to simulate long-term electrolysis conditions. By subjecting materials to extended electrochemical cycling under realistic operating conditions, researchers can observe and analyze how vacancies and defects evolve over time. This experimental approach, combined with thorough material characterization before and after aging, can offer valuable data on the stability and electrocatalytic performance of the materials.

Another avenue for research involves computational modeling and simulations to predict the evolution of vacancies and defects under various electrolysis conditions. Advanced computational techniques, such as density functional theory (DFT) calculations, can provide insights into the thermodynamics and kinetics of defect formation and migration. Combining these simulations with experimental data can contribute to revelations of the long-term behavior of electrocatalytic materials.

Furthermore, one additional strategy for increasing PEC efficiency is to develop a better co-catalyst. In smaller particles, the electro-kinetics dominate, resulting in increased electron−hole recombination. Larger particles exhibit band bending characteristics, allowing for better charge extraction at the electrode−electrolyte interface. Thus, bigger cocatalysts are preferred for the improved PEC performance.

Alternative options include optimizing the configuration of a PEC cell. Optimizing the arrangement of components within the cell would maximize light absorption, facilitate efficient charge separation, and improve the overall performance of the system. Utilizing tandem cell structures or multi-junction cells with semiconductor layers responsive to distinct wavelengths enables a more comprehensive absorption of the solar spectrum, reducing energy loss and enhancing the overall photon-to-current conversion efficiency. Designing the photoanode and photocathode configuration carefully, along with selecting appropriate electrolytes and integrating effective catalysts, contributes to minimizing overpotentials and improving the kinetics of the oxygen and hydrogen evolution reactions. Additionally, the spatial separation of these reactions within the cell mitigates energy losses associated with simultaneous processes.

Works Cited

Dolai, Sukdev, et al. "Exfoliated molybdenum disulfide-wrapped cds nanoparticles as a nano-heterojunction for photo-electrochemical water splitting." *ACS Applied Materials & Interfaces*, vol. 13, no. 1, 24 Dec. 2020, pp. 438–448, https://doi.org/10.1021/acsami.0c16972.

Marwat, Mohsin Ali, et al. "Advanced catalysts for photoelectrochemical water splitting." *ACS Applied Energy Materials*, vol. 4, no. 11, 26 Oct. 2021, pp. 12007–12031, https://doi.org/10.1021/acsaem.1c02548.

Liu, Yongjie, et al. "A mini review on Transition Metal Chalcogenides for electrocatalytic water splitting: Bridging Material Design and practical application." *Energy & Fuels*, vol. 37, no. 4, 2 Feb. 2023, pp. 2608–2630, https://doi.org/10.1021/acs.energyfuels.2c03833.

Li, Changqing, and Jong-Beom Baek. "Recent advances in noble metal (pt, Ru, and ir)-based electrocatalysts for efficient hydrogen evolution reaction." *ACS Omega*, vol. 5, no. 1, 18 Dec. 2019, pp. 31–40, https://doi.org/10.1021/acsomega.9b03550.

Yu, Xuelian, et al. "Cu2znsns4–ag2s nanoscale P–N heterostructures as sensitizers for photoelectrochemical water splitting." *Langmuir*, vol. 31, no. 38, 16 Sept. 2015, pp. 10555–10561, https://doi.org/10.1021/acs.langmuir.5b02490.

Ju, Lin, et al. "Janus wsse monolayer: An excellent photocatalyst for overall water splitting." *ACS Applied Materials & Interfaces*, 23 June 2020, https://doi.org/10.1021/acsami.0c06149.

Jing, Haitong, et al. "Sulfur vacancy-enriched rhombohedral Znin2s4 nanosheets for highly efficient photocatalytic overall water splitting under visible light irradiation." *ACS Applied Energy Materials*, vol. 5, no. 8, 10 Aug. 2022, pp. 10187–10195, https://doi.org/10.1021/acsaem.2c01930.

Daeneke, Torben, et al. "Surface water dependent properties of sulfur-rich molybdenum sulfides: Electrolyteless gas phase water splitting." *ACS Nano*, vol. 11, no. 7, 14 June 2017, pp. 6782–6794, https://doi.org/10.1021/acsnano.7b01632.

What are key factors influencing the contemporary international management of Central Asia? By Linara Angarova

Introduction

Overview of Kazakhstan's Economic Landscape: Outline Kazakhstan's position in the global and regional economy, focusing on key sectors.

Kazakhstan, positioned as Central Asia's largest and most resource-rich state, plays a significant role in the global and regional economy, underpinned by its substantial natural resources and strategic geographic location. The backbone of its economic strength lies in the oil and gas sector, which dominates the national GDP, exports, and government revenue, featuring some of the world's largest oil fields like Tengiz and Kashagan. Beyond hydrocarbons, Kazakhstan is endowed with significant mineral resources, making it a leading global producer of uranium, as well as a major player in the mining of coal, copper, and gold. The agricultural sector, though overshadowed by the extractive industries, remains vital, with Kazakhstan being a significant producer of wheat and livestock. Moreover, efforts to diversify the economy have seen growth in the financial services sector, underscored by the establishment of the Astana International Financial Centre (AIFC), aiming to become a financial hub for the broader region. In order to strengthen its position on the international scene and promote sustainable development, Kazakhstan, a key participant in regional economic organizations like the Commonwealth of Independent States (CIS) and the Eurasian Economic Union (EAEU), is stepping up its efforts. Kazakhstan's potential for further growth and development in the upcoming years is highlighted by this strategic posture, which is combined with efforts for economic modernization and integration into the global economy. [1]

2. The Role of Management Practices: Discuss the importance of effective management practices in driving organizational and economic success.

Effective management practices are fundamental to the success of organizations and, by extension, the broader economic prosperity of a nation. In Kazakhstan, where the economy is navigating through a phase of diversification and modernization, the role of adept management cannot be overstated [2]. These practices encompass a wide range of activities, including strategic planning, resource allocation, performance management, and innovation leadership, all of which are critical for achieving operational excellence and sustainable growth.

At the economic level, the aggregate effect of efficient management practices across organizations contributes to national competitiveness, economic stability, and growth. It facilitates the effective utilization of Kazakhstan's vast natural and human resources, positioning the country as an attractive destination for foreign investment. Furthermore, as Kazakhstan seeks to assert its presence on the global stage, the adoption and adaptation of international management standards within the context of its unique cultural and historical backdrop highlight the strategic interplay between global integration and local identity [3]. Thus, the importance of effective management practices in Kazakhstan transcends the organizational boundary, influencing the broader trajectory of economic development and international cooperation.

Research Objectives and Questions

     With an emphasis on the adoption of worldwide management standards like ISO, Six Sigma, and Lean Management and their integration with Kazakhstan's rich cultural legacy, this research intends to dive into the nuances of contemporary management practices in Kazakhstan. Understanding the impact of traditional Kazakh values and Soviet legacies on management practices, assessing the prevalence and difficulties of adopting these standards across different sectors, and conducting a comparative analysis with other nations to pinpoint distinctions and lessons gained are all goals of the study [4]. The main study topics will examine the motivations behind the adoption of international standards, how cultural variables affect these standards' application and efficacy, and how these standards ultimately affect organisational success and the nation's economic growth. In order to improve competitiveness and promote economic growth in the global marketplace, the research intends to provide insights into how Kazakhstani businesses may harmonise global management trends with local cultural values by looking at these elements.

Literature Review

ISO Standards

     The International Organisation for Standardisation (ISO) establishes widely accepted standards with the goal of guaranteeing the efficiency, safety, and quality of goods, services, and systems. The most well-known of them is ISO 9001, which focuses on quality management systems. Studies show that increased customer happiness, better product quality, and increased operational effectiveness are all correlated with ISO certification. On the other hand, difficulties including the high initial implementation costs and the requirement for continuous adherence to the standards are also mentioned [5]. A wide range of sectors have adopted ISO standards, demonstrating their importance as a trade facilitator on a global scale.

Six Sigma

     The DMAIC (Define, Measure, Analyse, Improve, Control) framework is the foundation of the Six Sigma technique, which aims to improve process outcomes by reducing variability and flaws. Case studies showcasing Six Sigma's effectiveness in industries ranging from manufacturing to healthcare abound in the literature, proving its ability to drastically cut mistakes and operating expenses. However, the literature also notes that there are obstacles, such as cultural opposition and the need for intensive training.

Lean Management

     Lean Management has its roots in the manufacturing sector and focuses on minimising waste and optimizing processes to create value for the customer. Its tenets of respect for people and continual development have been applied to a variety of industries, including services and healthcare, encouraging improvements in delivery times and quality. The body of research

emphasizes the need for a shift in culture towards lean thinking and stresses the importance of employee engagement and leadership in ensuring its successful application [6].

Theoretical Framework

International management standard adaptation to local cultural settings is a complex process that necessitates a thorough comprehension of both the local cultural quirks that may influence standard acceptance and the global standards being applied. Using Kazakhstan as an example, this integration framework encompasses a number of crucial tactics and factors to guarantee that global techniques are successfully adapted to match the unique requirements and preferences of the local setting.

Cultural Sensitivity and Awareness

To begin integrating international management principles, one must first have a keen understanding and sensitivity to local culture. This entails being aware of the significant power distance, collectivist culture of Kazakhstan, and the value of interpersonal ties in commercial transactions. In order to ensure that the application of these standards respects and is consistent with local cultural norms, managers and staff can benefit from cultural sensitivity training. This can assist close the gap between international standards and local practices.

2. Localized Implementation Strategies

Localized implementation techniques that take into account the corporate context, regulatory environment, and cultural norms are necessary for adapting international management standards. This would entail changing Kazakhstan's leadership philosophies to be more inclusive but hierarchical in order to make sure that team consensus and input are taken into account throughout centralized decision-making processes. In order to improve comprehension and acceptance of the standards, localizing implementation tactics also entails utilising language and communication styles that are appealing to the workforce in the area.

3. Leveraging Local Expertise

Including local knowledge is essential to successfully implementing international standards. Involving local managers and staff in the adaptation process promotes a sense of ownership and commitment to the implementation while also offering insightful information on how the standards might be used most effectively. This can entail assembling cross-functional groups with local and foreign specialists to work together to create adaptation plans that are relevant both locally and worldwide.

4. Flexible Application of Standards

Cultural variations must be taken into account by using international management principles with flexibility. This entails permitting differences in the application of standards as long as the fundamental goals of the standards are fulfilled. For example, whereas Lean Management prioritizes efficiency and waste reduction, its use in Kazakhstan may place more

focus on team building and aligning process improvements with the organization's overall goals, reflecting the local culture's emphasis on collectivism and collaboration.

5. Continuous Learning and Feedback Loops

The process of implementing worldwide management standards in a culturally unfamiliar setting is iterative and benefits from ongoing education and criticism. The integration of these standards can be improved by routinely evaluating the performance of the modified practices and making modifications in response to input from regional stakeholders. The adaptation process may be kept active and sensitive to local requirements by establishing feedback loops through surveys, focus groups, and open forums.

Findings and Analysis

Oil and Gas Sector: Tengizchevroil LLP (TCO)

TCO's use of ISO standards in the oil and gas sector most likely centers on environmental and safety compliance, which is necessary to uphold operational effectiveness and satisfy global regulatory obligations. Applying Six Sigma techniques might help reduce process variability, which is important in a field where accuracy and security are crucial. Lean Management emphasizes a sector-specific adaptation of global techniques to local operational demands, which may be used to improve supply chain efficiency [9].

Mining Sector: Kaz Minerals

In order to comply with worldwide environmental norms, draw in foreign investment, and demonstrate its commitment to sustainable mining methods and worker safety, Kaz Minerals is pursuing ISO accreditation. In this situation, implementing Six Sigma would concentrate on increasing the efficiency of mining and processing, focusing on regions with high costs and unpredictability. Applying lean management concepts might save waste and maximize resource use, showcasing an industry-specific strategy for incorporating global standards.

Agriculture Sector: KazExportAstyk

Adopting ISO standards, according to KazExportAstyk, guarantees product quality and safety while satisfying the demanding demands of global markets [10]. Lean Management techniques may optimize the supply chain from manufacturing to distribution, cutting waste and increasing the effectiveness of delivering goods to market. Six Sigma approaches might improve agricultural operations by decreasing variability in crop yields and enhancing quality control.

Conclusion

The adoption of international management standards in Kazakhstan, including ISO, Six Sigma, and Lean Management, has been studied. The study emphasizes how difficult it is to match global business practices with regional cultural norms. It demonstrates the growing adoption of these standards, which are intended to improve productivity, quality, and worldwide competitiveness, in industries such as banking, mining, and oil.

According to the research, adopting these methods is significantly impacted by Kazakh cultural qualities like collectivism and large power distance, which calls for the need for customized management solutions. It highlights industry-specific adoption barriers, most notably in the oil and gas sector where stringent regulations are in place, in contrast to sectors like agriculture where technology is used selectively to improve customer satisfaction and operational efficiency.

The research describes the delicate balancing act businesses must do when merging global practices with local customs. Leadership and communication styles must be modified to satisfy both local and international norms. Notwithstanding the advantages, there are several drawbacks, such as installation costs, the requirement for continual training, and upholding a commitment to continuous development. The study, which places a strong emphasis on creativity and adaptability, identifies Kazakhstani businesses that are prepared to change and combine local and global strategies to improve their market position. These organizations also provide insights into how to handle international management methods in a variety of cultural contexts.

Works cited

1. Triandis, H. C. (1995). Individualism & Collectivism. Westview Press.

2. Trompenaars, F., & Hampden-Turner, C. (1997). Riding the Waves of Culture: Understanding Diversity in Global Business. McGraw-Hill.

3. Meyer, E. (2014). The Culture Map: Breaking Through the Invisible Boundaries of Global Business. PublicAffairs.

4. Puffer, S. M., & McCarthy, D. J. (2011). "Two Decades of Russian Business and Management Research: An Institutional Theory Perspective." Academy of Management Perspectives.

5. Morris, M. H., & Pavlov, O. A. (2012). "The role of adaptive culture in predicting entrepreneurship in Kazakhstan: A model of entrepreneurial activity." Cross-Cultural Management: An International Journal.

6. Fey, C. F., & Denison, D. R. (2003). "Organizational Culture and Effectiveness: Can American Theory Be Applied in Russia?" Organization Science.

7. Schein, E. H. (2010). Organizational Culture and Leadership. Jossey-Bass.

8. House, R. J., Hanges, P. J., Javidan, M., Dorfman, P. W., & Gupta, V. (Eds.). (2004). Culture, Leadership, and Organizations: The GLOBE Study of 62 Societies. Sage Publications.

9. Adler, N. J. (2008). International Dimensions of Organizational Behavior. South-Western Cengage Learning.

10. Earley, P. C., & Ang, S. (2003). Cultural Intelligence: Individual Interactions Across Cultures. Stanford University Press.

11. Hofstede, G., Hofstede, G. J., & Minkov, M. (2010). Cultures and Organizations: Software of the Mind. McGraw-Hill.

12. Thomas, D. C., & Inkson, K. (2009). Cultural Intelligence: Living and Working Globally. Berrett-Koehler Publishers

The cause and impact of increasing frequencies of wildfire correlated with humidity By Seongyeol Choi

Abstract

The pervasive aftermath wildfires have left for humanity continues to entice more and more interest in researching it. With the push of various factors that drive wildfires to spread, it is crucial to understand how these perilous natural phenomena happen and threaten innocent citizens. This paper delineates the possible causes through the scope of capricious climate change, human activities, topography and weather, specifically humidity. When these great impacts and causes are considered, readers will be able to acknowledge that these phenomena narrow down to one chief, standing idea of humidity and wildfire.

KEYWORDS: Climate, Humidity, Topography, Weather, Human Behavior, Wild fire,

Introduction

With the rising number of wildfires, this phenomenon has affected almost every vegetated land on Earth. For decades, scientists and researchers have scrutinized the aftermath of wildfires, cause of minute to immense wildfires, and contribution to societal and environmental changes. Undoubtedly, as humanity further distresses the planet, the number of wildfires will significantly increase at an exponential rate. These atrocious and brutal consequences the wildfires have left for us has heightened my concealment into writing this research paper in order to examine numerous strategies to prevent wildfires, understand the major causes, and alleviate the cruelty of wildfires after they sweep the towns of innocent people.

Lists of organizations and institutions focused their visions in preventing wildfires that can be thwarted. WFCA stated that the U.S department of fire administration offers training courses, technologies, and materials in both preventing and ceasing fires to spread across the vast fields. Likewise, after the enormous wildfire during the 2019-2020 fire season in Australia, the government has input $200million dollars (U.S dollars) into recovering the native habitats and devastating impacts it has left, according to D.C.C.E.E.W. The most burning controversy in this field is about whether this natural phenomenon can be prevented through human effort and advancing technology.
While many more wildfire behaviors are being predicted and measured through concise and on-point technologies, it is unarguably true that the increasing rate cannot be returned within our own hands.

Therefore, this paper will examine the impact, aftermath, and understand what wildfires activities are. Understanding the phenomena, citizens will be able to be aware of its perilous consequences. The readers will hopefully be able to comprehend the vision that humanity is leaning towards the field of wildfire and the global trend of wildfir

Methods: Correlation of Climate Change and Wildfire:

The 2019-2020 fire season has left disastrous aftermath on the land of Australia. Around 45 million acres of land were burnt to ashes along with about 3000 houses that were home to innocent people, while also triggering 65000 new displacements for the households who were forced to move out (IDMC). Not only that, Australia has been financially damaged after the wildfire swept across the dry, arid lands. Between $44 million and $55 million had to be compensated just for the homes that were lost and abandoned due to the wildfire, and the agriculture of Australia, the primary economy in the nation, has been affected with an astounding amount of about $5 billion. This astronomical cost for the farmers is about 8 percent of the whole Australia's agriculture GDP (University of Sydney). As seen, consequences of the daunting wildfire are noxious for citizens. Indeed, the preeminent cause of the wildfire of the 2019-2020 Australian wildfire season was fluctuating temperature on the surface of the Indian ocean, a result of climate change.

El nino effect and Indian ocean Dipole, mainly caused by rise in ocean temperature, are the occurrences that have impacted the Australian primarily. El Nino, meaning effect is a climate pattern that causes the surface of ocean temperature to unusually heat up than average climate years. This climate phenomenon affects continents from Australia to South America by heating their vegetated land, making vast fields of land vulnerable to wildfires. The El Nino effect has happened for more than 4 centuries. However, what makes the recent events more unique is that with the rising greenhouse gas, the temperature of the planet itself has risen to the point where ocean surface has increased with it too. The El Nino effect specifically dried out Australia during the 2019-2020 season, which caused wildfires to spread at a speed that was unpredictable. Not only for Australia, but the El Nino effect was also carried to parts of Americas, such as California, where many more frequent wildfires happened during the El Nino seasons. FIG 1) Area burned in million acres along with the years. Each color is indicated by the legend. The more area of red means more greenhouse gases.

Damage Caused by Wildfires in the United States, 1984–2018
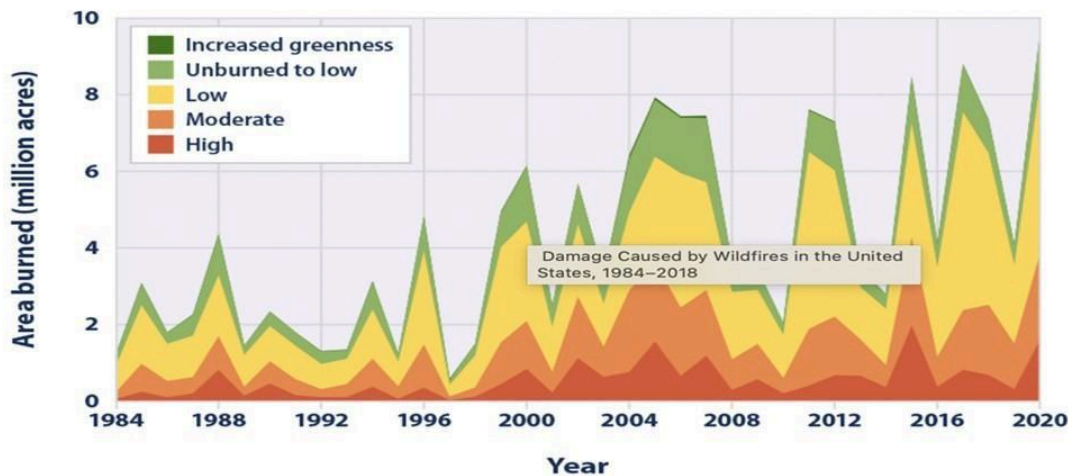
Figure1) Area burned in million acres along with the years. Each color is indicated by the legend. The more acres of red means greenhouse gases

The figure above, from the United States E.P.A, focuses on the severity of wildfire as the year progresses, along with the worsening of climate change. In addition, the acres burned in 2020 contrasts dramatically with that of 1984, depicting the

The Indian Ocean Dipole Mode Event is the other natural phenomena that contributed to the great wildfires in Australia. This event is when the western Indian ocean surface is warm compared to the eastern Indian ocean surface. The temperature difference causes unusual climates in the regions that the Indian ocean meets with. For instance, because of this phenomenon, Australia had to go through drier and arid spring seasons compared to Africa where the climate was clearly the opposite. It is prominent to realize the severity of the increasing dates of these events because the Indian Ocean Dipole Mode Event increases the threats of flooding in Africa and perilous wildfires in Australia. The correlation between wildfires and climate changes has been studied for years now, and many researchers found out that the more humans worsen and speed up climate change, it is unavoidable to encounter wildfires that are greater than ever before.

Human activities and Wildfire:

While climate change is one of the main causes of wildfires that happen in various continents, human activities are also a great cause of wildfire. Studies have shown that 86 percent of United states' wildfires are ignited by human activities, such as discarded cigarette put to dried bush, leftover camping material dumped, and equipment malfunctions. Furthermore, human activities causing wildfires were responsible for about 97 percent of the houses burnt from wildfires that happened in California.

Not only the fact that human caused fires are very common, they are more perilous and easily

Year	Acres burned (lightning-caused fires)	Acres burned (human-caused fires)
2021	4,101,884	3,023,759
2020	4,123,523	5,998,813
2019	3,447,038	1,217,324
2018	3,127,003	5,640,489
2017	5,195,610	4,830,476
2016	1,743,385	3,766,610
2015	8,112,688	2,012,461
2014	2,012,843	1,582,770
2013	3,057,566	1,261,980
2012	6,825,989	2,500,249

spread compared to other wildfires that happen in fire hazard regions. Through probing about 220 wildfires that happened between 2011 and 2020, when a fire was started by human activities such as burning cigarettes, camping apparatus and manmade objects, the average speed of the fire spreading was 1.83 km per day (Hanston). On the other hand, lightning-induced burns were spreading at a speed of about 0.83km per day, which is nearly half the speed of that of human ignited fires.

FIG 2) Acres burned annually. The left side shows lightning caused fires and the right side data

shows human caused fires. Figure 2 specifically shows the acres that were burned by both lightning-caused fires and human- caused fires. The fact that the fire started out by human activities is taking more and more land is devastating.

It is true that solving problems such as climate change to prevent wildfires can be started; however, implementing campaigns and spreading words in the areas of easily inflammable mountains can assuredly bring up the possible awareness of citizens to realize how much they are leading themselves into the igniter. In fact, it is somewhat ironic to witness the human-built infrastructure such as gas stations, electric wires, and many other man-made objects for human convenience to come back as an immense wildfire, killing hundreds of people.

Topography and wildfire:

While many individuals consider the causes as the essential point of researching, it is also crucial for people to understand how wildfire is spread. There are a broad spectrum of factors that lists from weather to building materials. However, the geographical effect of wildfire is often overshadowed by other well-known factors. Indeed, understanding the topographical effect of wildfire spreading will bring readers of this paper better knowledge about numerous ways immense fire can be prevented. Furthermore, topography in fact contributes a pivotal role in the dynamic of wildfire with various aspects : slopes, aspect, fuel, and weather.

Slope gradient is indeed the most important factor that contributes to the spread of wildfire. For example, many researchers from different intuitions have strongly affirmed that the higher the incline of a hill is, the faster the wildfire spreads along the hills of vulnerable areas. Along with the fuel materials on the ground, the wildfires spread their heat uphill faster than they do when a fire is heading downhill. To be more specific, when heat is created and it ascends up to the sky, it preheats the fuel of wildfire, such as dried leaves; woody debris; and vegetation, allowing the speed of wildfire to accelerate even higher. In fact, according to a notion from Charles Darwin University, every 10 percent increase in the slope can almost double the rate of fire spread.
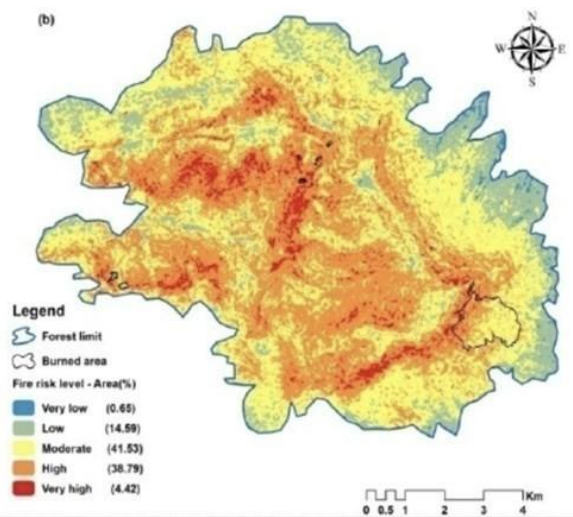
FIG 3) The mountain range is drawn in 3D

The figure emphasizes the effect of direction of the Mountain. mountain sides of mountain ranges tend to receive more light which leads to having fuels already preheated before the fire contacts. On the other hand, north-facing sides are known to be less vulnerable to fire spread than the south-facing hills, even though wildfire somehow still spreads. Nevertheless, because there is more fuel loading in the north side, the severity of the wildfire is usually more hazardous, according to Oregon state university. Admittedly, it is not going to be a panacea by just looking around the south sides, but giving more attention to south facing sides will undoubtedly help to detect fire. An image from UBC, fig 4, contains the sunlight hitting the mountain sides and explains how the mountains in the northern hemisphere get affected with more solar radiation and heat on the south side of the hills/ mountains.

The landscape of the geographics is the chief idea to understand the spread of wildfire. When wind passes canyon, ridges, and mountain ranges, the wind pattern fluctuates from being very slow to extremely fast, causing wildfire to intensify rapidly. As researchers from Oregon State University state, many wildfires are driven and led by wind, which controls how wildfires spread and maximize their size. Therefore, if wind velocity is increased through the landscape of mountain ranges, the spread of wildfire will evidently increase too. Valley winds are winds that build up in valleys and they take about 1 to 2 days to build up. The 2017 Tubbs fire and 2016 Chimney Tops 2 Fire are great examples of wildfires that were pushed by high-speed winds. In fact, lasting for more than 27 days, the Tubbs Fire burnt 3000 homes of innocent families and killed 22 people. When the valley wind is at its highest speed, the spreading of wildfire will be inexorable (NWCG members). Conversely, landscapes such as cliffs, rivers, lakes, and manmade roads are stopping points for wildfires to slow their speed down. Indeed, roads do adversely affect wildfires for a few cases. Many researchers from WildEarthGurdians state that the climates within the forests are impacted by the artificial roads since they consume heat and alter the normal climate pattern that exists within the region. The arrangement of the roads can be a significant influence to where the fire is started and how it is spread, causing few predicaments to the ecology.
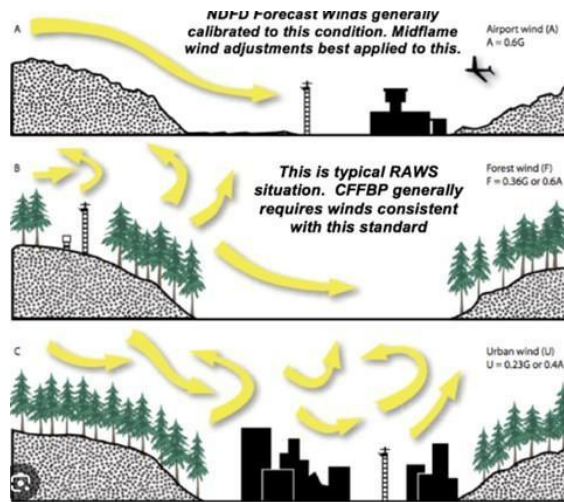
FIG 5) The figure from NWCG shows wind Pattern in different landscapes.
Figure 5, according to NWCG, wind patterns vary when the landscape differs. For instance, when there is an urban city in between hills or mountains, the building alters the wind flow, which changes how wildfires spread too. However, when wind is heading straight forward towards another geographic feature, and no obstacle thwarts the wind flow, the wildfires that accords with the wind will spread rapidly.

Humidity and Wildfire:

As our planet goes through many incidents of extreme weather, and change in climate behavior, many wildfires are unable to be predicted. Burning lightning can drop from the sky all of the sudden, starting as a little, minute fire and growing into a life-taking wildfire. Lightning occurs in various parts of the world, but the United States encounters more frequently than some parts of the globe. Thus, in the terms of wildfire behavior, weather is the most unexpectable factor that influences the most to being the precursor of wildfires. Humidity contributes to broad ranges of the start factor of forest fires, and also weather can correlate with the start of the wildfires.

Relative Humidity (RH) and Dew point are measures of moisture in the air and ground. Dew point is defined as the set temperature in order for a dew, or a fog, to be produced. Relative humidity is measured in percentile and as the percentage drops, it indicates that there is less water vapor in the air. Relative Humidity and dew point have direct influence in fire behaviors. These two phenomena connect closely to the fuel of the fire. For example, if dry fuels and relative Humidity drop more than 30 percent, there is a high possibility that if a fire breaks out, the spread of it will be fast and vast (DEFS). This natural phenomenon shows how the low moisture content of the fuel on the ground of the field where a fire starts can lead to behaviors that are amorphous and dubious. According to the study by open snow, humidity values that are 15 percent or lower can lead to an elevated fire. Also, when that percentage drops by less than 10 percent, a perilous and immense fire danger can be seen. The change in dewpoint and relative humidity might also indicate the change in wind pattern.

Temp (C)	Dew Point (C)	RH (%)	Dead fuel moisture (%)	Relative Rate of Spread
25	10	39	7	x 1
25	0	19	4.5	x 2

FIG 6) Figure from DEFS shows the relationship between RH and Dew Point with the rate of spread of wildfire.

FIG 6 from DEFS clearly shows in numbers how RH and Dew Point relates to the relative rate of spared of wildfire. As the Dew point decreases by 10 degrees and RH decreases, the relative rate of spread has increased by scale factor of 2.

Conclusion:

With the escalating wildfire phenomenon across the globe, the paper has dived into the intricate and close relationship between wildfire and humidity, focusing primarily on climate change, human activities, topography and moisture contents. The results after examining these distinctive methods were indeed surprising in a way that all factors have connections to each other that narrows down to one idea.

When examined through the lens of climate change, specifically the Indian Dipole Mode Effect and El Nino effect, the majority of the wildfire behavior was stratified into one clear idea. Both Indian dipole mode effect and El Nino effect contributes to the temperatures of countries this paper has mentioned about. In addition, the two natural phenomena have relations with dryness of the regions these effects happen. This link between temperature and effects emphasizes the importance of humidity in wildfire along with these ideas. For instance, as stated in the methods, as the Indian Dipole Mode effect brings a sudden rise in temperature for a country like Australia, it will go through a dry fall season that is drier than ever before. Furthermore, when a state like California encounters El Nino phenomena during its fall season, fuel dries up faster than ever before, bringing up the possibility of starting a wildfire. Indeed, according to research by bioscience, for example, during the past 2 decades, the relative humidity (RH) has been affected additionally by the El Nino effect, dropping the average humidity by around 1.5 to 5 percent. Not only that, research on the Indian ocean and humidity's correlation, the researchers have specifically elucidated that the difference in the highest RH and lowest RH during the season

when Indian dipole mode was about 10 percent when recorded data. This quantitative data illuminates the idea of the chain between climate change and humidity.

Although it might be overshadowed by other factors, human activities are the main cause of wildfire. High percentage of the wildfires are caused by human activities such as remnants of campfires, cigarette, and mountain activities. Additionally, when this cause of wildfire is delved and examined, many acknowledge human activities that cause wildfire are precisely connected with change in humidity, too. As spoken in the paper, human caused fires are not known to spread at a very fast speed that makes many forest fires to be unpreventable. Topography with its various causes of wildfire and its contribution to accelerating, it also connects with the notion of humidity and wildfire. Topography as said in the paper, its slope affects the spreading of wildfire. For instance, the steeper the mountain or the hill is, the faster the wildfire will expand on the dry land.

Furthermore, when the direction the mountain side is facing is towards the south, mountains have a higher possibility of starting an immense wildfire than the sides of mountains that face the north. In addition, their geographical formation leads to altering the wind pattern; therefore, the rate of spread of wildfire is accelerated even faster and may even change the direction the fire is heading towards. All of these factors have some connection to moisture content in the fuel since the lower the RH of the region is, the higher the chance of the possibility of starting a wildfire is. To extend this idea, the geographical effect to creating these dry fuels and where they are formed are closely related to the topographical effects to forest fires. In addition, mountain ranges have a relative humidity of around 30% to 50 % on average days. However, when this percentage drops down to 20%, the risk of causing fire skyrockets. This links how relative humidity has great connection with topography when touching on the field of wildfire.

As said through all 3 methods, when relative humidity and moisture content in fuel plays a chief role in causing a wildfire. The El Nino effect drops significant amounts of RH by around 1.5 to significant 5 percent, and topography of the area indicates the average relative humidity. Thus, when organizations measure and monitor, specifically during the dry fall seasons, the relative humidity and notice that the RH level has dropped more than 5 to 7 percent, they should start comparing previous knowledge of natural phenomenon going on around and alert nearby fire stations to start watching fire hazardous areas by imputing unmanned drones or balloons. These methods narrow to one but foremost idea of connection between humidity and climate change; human activities to fire; and topography.

Works Cited

Denson, Eleanor, et al. "Decreases in Relative Humidity across Australia." ProQuest, 1 July
2021, www.proquest.com/docview/2550679898?accountid=14681&pq-origsite=primo,
https://doi.org/10.1088/1748- 9326/ac0aca.

"Bushfire Recovery for Wildlife and Their Habitat - DCCEE." Dcceew.gov.au, 2022,
www.dcceew.gov.au/environment/biodiversity/bushfire-
recovery#:~:text=The%20Australian%20Government%20is%20investing.

Wang, Guojian, and Wenju Cai. "Two-Year Consecutive Concurrences of Positive Indian Ocean
Dipole and Central Pacific El Niño Preconditioned the 2019/2020 Australian "Black
Summer" Bushfires." Geoscience Letters, vol. 7, no. 1, 10 Nov. 2020,
https://doi.org/10.1186/s40562-020-00168-2.

National Geographic. "El Niño | National Geographic Society."
Education.nationalgeographic.org, 19 Oct.
2023, education.nationalgeographic.org/resource/El-Nino/.

University of Sydney. "Black Summer Bushfire Season Cost Farmers up to $5 Billion." The
University of Sydney, 13 Dec. 2021,
www.sydney.edu.au/news-opinion/news/2021/12/13/black-summer-2019-20-bushfires-
cost-farmers-5-billion-australia.html.

"2019-2020 Australian Bushfires." Center for Disaster Philanthropy, 14 Oct. 2020,
disasterphilanthropy.org/disasters/2019-australian-wildfires/.

Du Parc, Elisabeth, and Louisa Yasukawa. "The 2019-2020 Australian Bushfires." IDMC, Sept.
2020,
www.internal-displacement.org/publications/the-2019-2020-australian-bushfires-from-te
mporary-evacuation-to- longer-terms

"인도양의 쌍극현상(Dipole Mode Event)이 가져온 메뚜기 떼 출현과 호주 대형 산불 -
레저신문."
Www.golftimes.co.kr, www.golftimes.co.kr/news/articleView.html?idxno=126625. Accessed 29
Dec. 2023.

wfca_teila. "What Is the Government Doing to Prevent Wildfires?" WFCA, 23 May 2023,
wfca.com/wildfire-articles/government-doing-to-prevent-wildfires/.

"희망브리지 전국재해구호협회." Hopebridge.or.kr, 14 Jan. 2020,
hopebridge.or.kr/hope/view_p.php?board_idx=10356&board_type=NTC4&#:~:text=%EB%8B
%A4%EC%84%AF
%20%EB%8B%AC%20%EC%A7%B8%20%EA%BA%BC%EC%A7%80%EC%A7%80%20
%EC%95%8A%EB%
8A%94. Accessed 29 Dec. 2023.

"Indian Ocean Dipole (IOD) Index | Vital Signs." Ocean Surface Topography from Space,
sealevel.jpl.nasa.gov/data/vital-signs/indian-ocean-dipole/#:~:text=The%20Indian%20Ocean%2
0Dipole%20is.

Point, Dew. Relative Humidity and Dew Point.https://assets-global.website-
files.com/61de5d84c5a92d75c52a9ca6/62aaa059134cd26037ed8d3f_Relative-Humidity-
and-Dew-Point- Information-Sheet.pdf

OpenSnow. "Weather Factors That Influence Fire Danger." OpenSnow, opensnow.com/news/post/weather-factors-that-influence-fire-danger.

"Estimating Winds for Fire Behavior | NWCG." Www.nwcg.gov, www.nwcg.gov/publications/pms437/weather/estimating-winds-for-fire-behavior.

Sjöström, J., and A. Granström. "Human Activity and Demographics Drive the Fire Regime in a Highly Developed European Boreal Region." Fire Safety Journal, vol. 136, Apr. 2023, p. 103743, https://doi.org/10.1016/j.firesaf.2023.103743. Accessed 2 Mar. 2023.

US EPA. "Climate Change Indicators: Wildfires | US EPA." US EPA, July 2016, www.epa.gov/climate- indicators/climate-change-indicators-wildfires.

Joosse, Tess. "Human-Sparked Wildfires Are More Destructive than Those Caused by Nature." Www.science.org, 8 Dec. 2020, www.science.org/content/article/human-sparked-wildfires-are-more-destructive-those-caused-nature.

The Importance of Early Detection of Breast Cancer in Kenya And Implementation of a Pilot Patient Education Program By Victoria Sander

ABSTRACT

A comprehensive literature review was conducted to define the incidence, treatment challenges, and fatality rates for breast cancer in Kenya, as well as the social and environmental factors that influence patient outcomes. Research reveals that breast cancer is the most common cancer in Kenya and is the second leading cause of death from cancer. Cancer is proliferating in Kenya, in part due to increased urbanization and the resulting exposure to a broader population of carcinogens.

The rate of death from breast cancer in Kenya is 253% of the rate of death in the United States. In general, several factors impact breast cancer survival rates, including the average level of income and education of the population, and the strength of the health system. However, the stage of diagnosis is a critical variable, and unlike many of the more systemic factors, has the potential of being directly improved in the short run.

A significant proportion of breast cancer in low- middle-income countries such as Kenya is diagnosed at an advanced stage, decreasing treatment success rates. In contrast, in countries such as the United States, most patients are diagnosed at earlier stages. This difference may explain why rates of death from breast cancer are higher in Kenya and suggests the need for programs to increase awareness and screening for breast cancer in Kenya.

In response to the research showing the need for early detection of breast cancer in Kenya, a pilot program called Pink Ribbons Nairobi will be implemented in conjunction with local health agencies starting in Spring 2024 to educate women about breast cancer, prevention, and lifestyle changes. The program will be evaluated for its effectiveness by surveying participants before and after the program to measure, among other items, their awareness of the benefits of early detection and methods for prevention and detection. The goal of this program is to focus on specific actions that individual women and local agencies can undertake to reduce the risk of breast cancer.

INTRODUCTION

Research reveals that breast cancer is the most common cancer in Kenya and is the second leading cause of death, led only by cervical cancer (Jani et al.). A comparison of breast cancer patient outcomes in Kenya with global trends found a higher rate of deaths compared to breast cancer patient outcomes in higher-income countries and found that patients are being diagnosed at later stages in Kenya. The stage of diagnosis is a critical variable, and unlike many of the more systemic factors, it has the potential to be directly improved in the short term.

Due to the level of increased cancer rates, there is a need for programs to increase awareness and screening for breast cancer in Kenya. A pilot program called Pink Ribbons Nairobi will be implemented starting in Spring 2024 to educate women about breast cancer, prevention, and lifestyle changes.

LITERATURE REVIEW

A comprehensive literature review was conducted to characterize and quantify the epidemiology of breast cancer. The review initially targeted Nairobi and was expanded to cover Kenya more broadly as more information was available for this border population. The literature review identified major social and environmental factors in Nairobi that impair breast cancer prevention, detection, and treatment.

Epidemiology of Breast Cancer in Nairobi and Broader Kenya

Publications, government databases, and other sources primarily focus on Kenya, not Nairobi specifically, although they do highlight the high rates of cancer in Nairobi. In Kenya, cancer is a significant health issue, and it is the third leading cause of death after infectious diseases and cardiovascular diseases.

A comparison of breast cancer patient outcomes in Kenya reveals a higher rate of death compared to patient outcomes in higher-income countries. In 2020, the breast incidence rate in Kenya was 40.3 per 100,000 women, with a mortality rate of 17.8 per 100,000 (Igiraneza et al.). As a result, the rate of death from breast cancer in Kenya in 2020 is calculated to be 44.2% of the patients diagnosed. In contrast, in the United States, approximately 240,000 cases of breast cancer were diagnosed, and deaths from breast cancer approximated 42,000 women (CDC). The rate of death from breast cancer in the United States was 17.5% of the number diagnosed, as shown in

Figure 1.
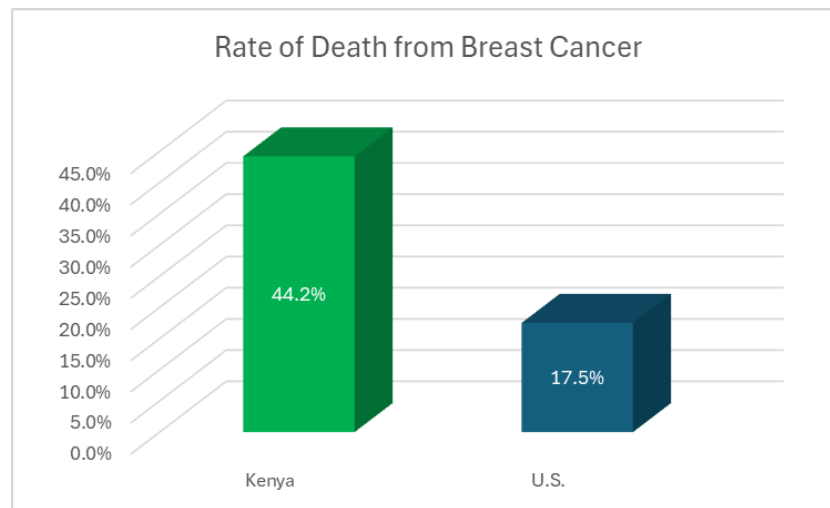
Figure 1. Igiraneza et al. for Kenya patient outcomes and CDC for United States patient outcomes.

This data suggests that the rate of death from breast cancer in Kenya is 253% of the rate of death in the United States. As noted further within this article, certain challenges exist in the treatment of cancer in Kenya, including resource constraints and other challenges in the delivery of medical services. However, there is also a clear relationship between the stage of diagnosis and patient outcomes, with evidence that patients in Kenya are diagnosed at a later stage.

Cancer is just a current challenge but is a growing health issue in Kenya as the number of new cancer cases is expected to rise by more than 120% over the next two decades (Jani et al.). Researchers attribute these increases in part to increased urbanization, either from population migration or urbanization of historically rural areas. A comparison of cancer rates across different regions of Kenya reveals that urbanization increases the risk of breast and lung cancer as a result of more people being exposed to carcinogens (Ministry of Health). In Kenya, the counties of Nairobi, Nakuru, and Kiambu have the highest cancer rates and are also heavily urbanized (Ongaji).

Another explanation for the expected increase in cancer cases is the future aging of the population. Currently, more than 40% of Kenyans are younger than age 15 (Jani et al.). Since age is a major risk factor for cancer, when the population ages, the incidence of cancer is also expected to increase. Lastly, unhealthy behaviors are expected to contribute to the incidence of cancer, as the use of cigarettes and new/other nicotine products and the obesity epidemic are expected to contribute to cancer risk (Ministry of Health).

Importance of Early Detection in Preventing Deaths from Breast Cancer

Early detection involves diagnosing cancer at an early stage when it has a high potential for cure. Delays to breast cancer treatment of greater than three months have been associated with more advanced disease stages at diagnosis and poorer survival (Ginsburg et al.). A review of survival rates for more than 1.3 million breast cancer patients from the United States National Cancer Database revealed that patients diagnosed with breast cancer at Stage I, an early stage, had an approximate 90% likelihood of achieving ten-year survival. In contrast, a patient diagnosed much later in the progression of their breast cancer, Stage IV, has an approximate 5% likelihood of ten-year survival (Singletary and Connolly).
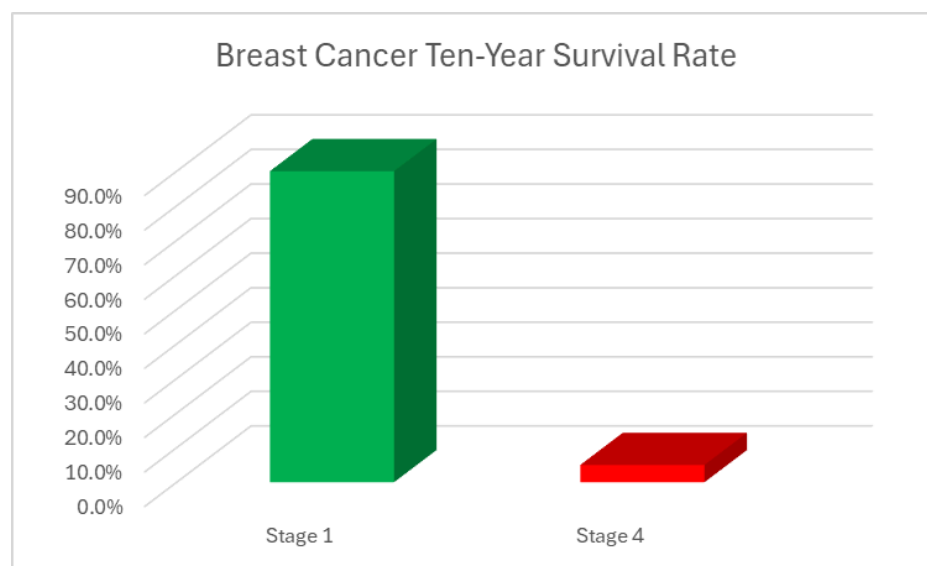
Figure 2. Breast Cancer diagnosis during Stage IV has a 5% likelihood of ten-year survival whereas diagnosis in Stage I has a 90% survival rate (Singletary and Connolly).

At the time of the diagnosis of breast cancer, an assessment is made of the stage of development of the patient's disease. Based on this assessment, the cancer is categorized as Stage I through IV, with Stage IV being the most advanced. A significant proportion of breast cancer in low- and middle-income countries is diagnosed at an advanced stage. For example, 75% of patients diagnosed with breast cancer in Sub-Saharan Africa, a region that includes Kenya, were late-stage (AJCC Stage III or IV) (Ginsburg et al.). In contrast, research evaluation of the effectiveness of breast cancer education in the United States revealed that by 1995, only 11.6% of breast cancer patients diagnosed were at Stage III or Stage IV (Singletary and Connolly). This difference may explain in part why the rate of death from breast cancer in Kenya is 253% of the rate of death in the United States. This research suggests the need for programs to increase awareness and screening for breast cancer in Kenya.

Social Factors in Nairobi that Impair the Prevention, Detection, and Treatment of Breast Cancer

Kenya is a middle-income Eastern African country with an ethnically diverse population of 54.7 million (Jani et al.). Risk factors, including lifestyle behaviors, limited sanitation, and potential exposure to pollutants like heavy metals in water systems, collectively contribute to the increased breast cancer rates. The inadequate healthcare infrastructure, limited resources, and gaps in data accessibility diminish effective prevention and treatment efforts.

A comparison of breast cancer survival rates across the globe demonstrates that they directly correlate with a country's GDP as well as its public spending on health (Ginsburg et al.). More specifically, cancer care in Kenya is hampered by several factors, including an inadequate cancer care infrastructure due to financial constraints. In Kenya, nearly 23% of sick patients do not seek health care due to several barriers, including high costs, the need to travel long distances, and a lack of healthcare literacy (Jani et al.).

There is also a low level of awareness about cancer in the general population within Kenya, including its risk factors and common prevention and control strategies. A study in rural Kenya showed that, although more than 80% of respondents had heard of breast cancer, fewer than 10% of women and male heads of households knew two or more of its risk factors (Jani et al.). Other factors impact breast cancer survival rates, including education, fertility rates, and the strength of the health system (Ginsburg et al.). However, the stage of diagnosis is a critical factor as many women are diagnosed at a later stage, diminishing their survival rate. Many factors impair the early detection of breast cancer in Kenya: lack of awareness about the importance of early detection; lack of education about the signs of breast cancer and techniques for self-examination; lack of access to medical screening; fear of early screening and detection, and concerns/hesitations about seeking medical care, in part because of the perceived stigma associated with cancer (Ginsburg et al.).

PINK RIBBONS NAIROBI – PILOT PROGRAM FOR BREAST CANCER EDUCATION

The results of the literature review highlighted the high rate of death from breast cancer in Kenya and the late stage of detection. Early detection, effective treatment of breast cancer, and prevention of this disease are dependent upon many factors, some of which are within the control of women and some of which require the broader cooperation of governmental and other agencies. For example, reducing pollutants in water and other parts of the environment is critically important but will require the broad support and action of the national and local governments.

In response to the research showing the need for early detection of breast cancer in Kenya, a pilot program called Pink Ribbons Nairobi will be implemented starting in the Spring 2024 to educate women about breast cancer, prevention, and lifestyle changes. The goal of this program is to focus on specific actions that individual women and local agencies can undertake to reduce the risk of breast cancer.

The mission of the Pink Ribbons program is to partner with medical agencies and women's groups to reduce the stigma around breast cancer and increase the likelihood of early detection. In Kenya, only 27% of women are aware of the signs of breast cancer. Creating an awareness program is essential to ensuring positive health outcomes for women who are affected by breast cancer while also providing support and empowerment. Workshops on breast health, screening education, and emotional support will be conducted and evaluated in these pilot women's groups.

The program will be evaluated for its effectiveness by surveying participants before and after the program to measure, among other items, their awareness of the benefits of early detection and methods for prevention and detection. Through the expansion of this program, the health education component will aim to increase the participants' awareness of breast cancer, the importance of early detection, and detection methods.

The sessions will also cover healthier living/lifestyle changes in the curriculum to promote healthy lifestyle habits to reduce the rise and risk of breast cancer. To achieve this, a specific diet plan focused on breast cancer prevention will be implemented into the education and awareness of this program. Cooking classes will be organized to teach healthy cooking methods and recipes, and exercises can be initiated.

Evaluation of The Pink Ribbons Program

Participants will be given a short survey in advance of the sessions to assess their pre-session level of understanding of key factors in detecting and preventing breast cancer. The medical team will provide screenings for breast cancer (for willing participants). Participants will also be asked to take an end-of-session survey to determine how effective the session was at increasing awareness and understanding among the participants. A follow-up 30-day survey will be given after the program to survey ongoing awareness of breast cancer and general health issues. After the sessions, the survey data will be summarized, and a comparison of pre-and post-program surveys will be conducted to determine if the program has been effective.

CONCLUSION

The results of a comprehensive literature review reveal that breast cancer is a significant health issue in Kenya and a major cause of death. The rate of death from breast cancer in Kenya is 253% of the rate of death in the United States. This high rate of death may be attributed in large part to the fact that breast cancer, such as in Kenya, is diagnosed at an advanced stage, decreasing treatment success rates, whereas, in high-income countries such as the United States, most patients are diagnosed at earlier stages.

In response to the research showing the need for early detection of breast cancer in Kenya, a pilot program called Pink Ribbons Nairobi will be implemented starting in the Spring of 2024 to educate women about breast cancer, prevention, and lifestyle changes. The program will be evaluated for its effectiveness by surveying participants before and after the program to measure, among other items, their awareness of the benefits of early detection and methods for prevention and detection. The goal of this program is to focus on specific actions that individual women and local agencies can undertake to reduce the risk of breast cancer and meet the health and behavioral objectives set forth.

There has been much advancement over the past 50 years in the detection and treatment of breast cancer. Programs are required in lower-income countries like Kenya to ensure that patients benefit from these advances.

Works Cited

CDC. "CDC - Basic Information about Breast Cancer." *CDC*, 2019,
      www.cdc.gov/cancer/breast/basic_info/index.htm .

Ekpe, Etoroabasi, et al. "Metastatic Breast Cancer in Kenya: Presentation, Pathologic Characteristics, and
      Patterns—Findings from a Tertiary Cancer Center." *Journal of Global Oncology*, vol. 5, no. 5, 10
      Dec. 2019, pp. 1–11, ascopubs.org/doi/10.1200/JGO.19.00036,
      https://doi.org/10.1200/jgo.19.00036.

Ginsburg, Ophira, et al. "Breast Cancer Early Detection: A Phased Approach to Implementation."
      Cancer, vol. 126, no. S10, 29 Apr. 2020, pp. 2379–2393,
      www.ncbi.nlm.nih.gov/pmc/articles/PMC7237065/, https://doi.org/10.1002/cncr.32887.

Igiraneza, Pierre Céléstin, et al. "Factors Influencing Breast Cancer Screening Practices among Women
      of Reproductive Age in South Kayonza District, Rwanda." *Canadian Oncology Nursing Journal*,
      vol. 31, no. 3, 22 July 2021, pp. 251–257,
      canadianoncologynursingjournal.com/index.php/conj/article/view/1185,
      https://doi.org/10.5737/23688076313251257. Accessed 5 Feb. 2024.

Jani, Pankaj, et al. "Cancer on the Global Stage: Incidence and Cancer-Related Mortality in Kenya - the
      ASCO Post." *Ascopost.com*, World Health Organization: Africa, 25 Mar. 2021,
      ascopost.com/issues/february-25-2021/cancer-on-the-global-stage-incidence-and-cancer-related-m
      ortality-in-kenya/.

Marmot, M G, et al. "The Benefits and Harms of Breast Cancer Screening: An Independent Review."
      British Journal of Cancer, vol. 108, no. 11, June 2013, pp. 2205–2240,
      www.ncbi.nlm.nih.gov/pmc/articles/PMC3693450/, https://doi.org/10.1038/bjc.2013.177.

Ministry of Health. "Guidelines, Standards & Policies Portal." *Guidelines.health.go.ke*, Ministry of
      Health, 15 June 2020, guidelines.health.go.ke/#/category/7/448/meta.

Ongaji, Pauline. "Revealed: Counties with the Highest Cancer Cases." *Nation*, 3 Feb.
      2023,nation.africa/kenya/news/revealed-counties-with-the-highest-cancer-cases--4109630.

Singletary, S. E., and J. L. Connolly. "Breast Cancer Staging: Working with the Sixth Edition of the
      AJCC Cancer Staging Manual." *CA: A Cancer Journal for Clinicians*, vol. 56, no. 1, 1 Jan. 2006,
      pp. 37–47, acsjournals.onlinelibrary.wiley.com/doi/full/10.3322/canjclin.56.1.37,
      https://doi.org/10.3322/canjclin.56.1.37.

Statistical Study of the Eigenvalues of Random Graphs through Random Matrix Theory By Vannsh Jagtiani

Abstract

Randomness is inherent in nature. From bacterial population growth to noise in electrical circuits, stochastic processes highlight the randomness which is evident in the inherent nature of physical phenomena. In this work we perform a numerical experiment by studying the statistics of eigenvalues of adjacency matrices of randomly connected graphs. We motivate graph theory and highlight the method of generating random graphs used for this study. We then look at the eigenvalues of the adjacency matrices to look at their eigen- spectrum. We further statistically observe the spacing distribution and find that the spacing exhibits Gaussian Orthogonal Ensemble (GOE) distribution.

Introduction

Random matrix theory is a field of mathematics which has been used to understand complex systems. The idea came by observation of the energies of heavy nuclei which exhibit complex many body interactions. This leads to energy levels not following a specific mathematical function. Wigner postulated, if the underlying processes are so complex, that they almost appear random, can they show some statistical relations? This led to exploration of random matrices and their eigenvalue distribution.

In this work, we work with the hypothesis that the eigenvalues of the adjacency matrix of a randomly connected graph demonstrates features from random matrix theory due to inherent randomness in the connectedness of the graph. We do this by using python. We create 1000 randomly connected graphs, each with 1000 nodes, giving us 1000000 eigenvalues, making it a large number for statistical significance. We then arrange these eigenvalues in the ascending order and calculate the spacings by subtracting adjacent values. These obtained values are then plotted as a histogram and compared with the GOE distribution.

GOE distribution is one of the distributions used to study many body interactions. This is visible in many nuclear reactions, molecular interactions and chaotic quantum systems. If we are able to draw a relation between the said distribution and randomly connected graphs, which can be easily modelled using modern tools like networkx in python, we can suggest a possible connection between the two. This can help us model complex nuclear reactions or similar many body phenomena using randomly connected graphs. This makes this work interesting and worth exploring in the broader picture of applications of GOE and random matrix theory.

Overview to graph theory and random graphs

Many real-world problems can be described by means of a diagram consisting of a set of vertices together with lines joining certain pairs of these vertices. The points could represent various entities, all the way from cities connected by major flight lines to houses in a colony joined by a set of streets. Such diagrams are known as graphs (West, D. B. 2001). A graph is essentially made of a set of "vertices" or "nodes" which are joined together by "edges". Such problems often can be thought of many players interacting in some manner to a certain dynamics.

The history of graph theory may be specifically traced back to as early as 1735 when Swiss mathematician Leonard Euler solved the Königsberg bridge problem. The Königsberg bridge problem was concerned with the possibility of finding a path over every one of seven bridges that span a forked

river flowing past an island but without crossing any bridge more than once. Euler argued that no such path existed. His proof essentially proved the first theorem in graph theory. Since the period, other discoveries in graph theory soon followed such as A.F. Mobius' Bipartite Graphs in 1840, the concept of trees by Gustav Kirchhoff in 1845, Thomas Gutherie's famous four color problem in 1852 and William R. Hamilton's Hamiltonian Graphs in 1856. In the year 1941, Ramsey worked on colorations which led to the identification of another branch of Graph Theory called extremely Graph Theory. The study of asymptotic graph connectivity gave rise to random graph theory.

Graph theory has significant real life applications in subjects like Chemistry, Biology, Physics, Computer Sciences and other fields of Operational Research (Mondal, B., & De, K. 2017). The specific fields that extensively use graphs are Biochemistry, Electrical Engineering through communication networks and coding theory, Computer Science through algorithms and computations, Operation Research through scheduling and detailing.

The specific study of Random Graphs in their own right began in the paper originally published under the name of Erdós and Rényi (P. Erdós and A. Rényi, Budapest) . A random graph as the name suggests, a graph generated at random with a number of edges and vertices.. Therefore, the probability space of the different number of random graphs that can be generated is huge and multiplies with a greater number of edges and vertices, as any vertex can be connected to an edge without prearrangement. The number of edges which connect to a vertex is known as the degree of that particular vertex.

In early days any literature explaining and conjoining the theories of random graphs was often scattered and ambiguous. In the first paper published in 1960 by Erdós and Rényi, not only was this subject matter made concise and clear but random graphs were also given specific types and models like Uniform Random Graph Model where a graph G(n,m) chosen uniformly from a set of graphs with a given set of vertices [n] and and m edges or Binomial Random Graph Model, where A graph G(n,p) with a given set of vertices [n] joined by an edge independently from the subject matter with probability p. In our work, we limit the scope to graphs generated as uniform random graphs.

Before we move to the adjacency matrix, we must realise that each of these graphs can be expressed in the form of a matrix. The matrix, an arrangement of rows and columns, forms a two dimensional square array which can represent the connectedness of the graph, known as adjacency matrix. The best way to describe the word "matrix" in mathematically accurate terms would be a set of numbers arranged in rows and columns to form an array. Matrices are an intricate yet concise way to store data in a form that is easily accessible and understandable. Matrices find a huge number of applications in operational sciences, computer science, engineering, physics, economics and graphics.

The form of a matrix is denoted with [aij] where i is the number of rows in a matrix and j is the number columns. The order of a matrix refers to the number of rows of the matrix multiplied by the number of columns of the matrix (i*j). Let's take a simple example:
[1 0 0]

This matrix is called a simple row matrix. As visible there is only a single row (i=1) while there are three columns (j=3) in this particular matrix. Hence, the order of the matrix (i*j) becomes 1x3.

An adjacency matrix, or simply known as a connection matrix, is a matrix pertaining to the edges connecting the vertices of a graph. It is a representation of the relation between different vertices connected to each other by edges. Each cell of an adjacency matrix represents if a vertex is connected to an adjacent vertex by an edge or not, and hence the value of that particular cell can be [0] for no

connection or [1] for an edge connecting them. Since we assume that if a vertex *i* is connected to a vertex *j*, vertex *j* is also connected to vertex *i*. This makes the adjacency matrix symmetric and hence the matrix is its own transpose.

For instance, this is a simple random graph(Kang, M., & Petrasek, Z. 2014) with four vertices labelled 1, 2, 3 and 4. In this specific graph, the vertex 1 has zero connections with itself, zero connections with vertex 2, zero connections with vertex 3, but one edge connecting it to vertex 4. Hence, its row with adjacency calculation becomes [0 0 0 1]. As the process is completed with every single vertex in the graph, an adjacency matrix with a set number of rows and columns is generated, in binary with all cells being occupied with either 0 or 1.
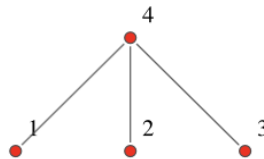
$$\begin{pmatrix} 0 & 0 & 0 & 1 \\ 0 & 0 & 0 & 1 \\ 0 & 0 & 0 & 1 \\ 1 & 1 & 1 & 0 \end{pmatrix}$$

Figure 1: Example of a graph and its Adjacency matrix. Each vertex, if connected to another vertex, gives a 1 weight to the corresponding element. Since we assume bijection, i.e. if a vertex is connected to another vertex, that implies the reverse is also true, this makes the adjacency matrix symmetric.

Random Matrix Theory

Many real life comparisons between random matrix theory can be applied in fields of Nuclear Physics, Electrical Engineering, Data Analysis, Computational Neuroscience and Quantum Mechanics. The wigner distribution is often seen in data analytics of all such fields such as in the modeling of the nuclei of heavy atoms, quantum optics, matrix multiplication etc. Through the material ahead, we would like to present a similar distribution through random matrices of uniform randomly generated graphs.

Random matrix theory is the study of matrices with random entries. When the eigenvalues of an ensemble of such matrices are studied, they show a specific kind of distribution and properties. The spacing in these eigenvalues when plotted, shows primarily three kinds of relations, Gaussian unitary ensemble (GUE), Gaussian orthogonal ensemble (GOE), and Gaussian symplectic ensemble (GUE). In this work, we limit our discussion to the GOE type distribution.

A matrix A_N is called Gaussian orthogonal ensemble (GOE) if

- A_N is symmetric;
- $A_N(i, i) \sim N(0, 2)$ for i = 1, ..., N and $A_N(i, j) \sim N(0, 1)$ for $1 \le i \le j \le N$;
- $(A_N(i, j))$ independent for $1 \le i \le j \le N$.

The spacing ratios are given by:

$$P(r, \beta) = C_\beta \frac{(r+r^2)^\beta}{(1+r+r^2)^{1+3\beta/2}}$$

Where β = 1 for GOE ensemble and C_β is π/2. The probability distribution looks like the following.

$$p_1(s) = \frac{\pi}{2} s e^{-\frac{\pi s^2}{4}}$$

The above equation gives the distribution function of GOE which can be compared with the eigenvalue distribution for checking the validity of the GOE for our set of eigenvalues.

Methodology

We begin by generating 1000 random Erdós Rényi graphs with 1000 vertices. This is achieved by using the networkx package in python. We then look at the adjacency matrix of each of these matrices. The spectrum or the eigenvalues of these adjacency matrices are calculated. Only the real values of these eigenvalues are considered. We then calculate the spacings of these eigenvalues by sorting these eigenvalues in ascending order and calculating the next neighbors difference. The histogram is plotted and compared with the GOE distribution.

Random Graph Generation:

The first step for this data analysis is the generation of random graphs using a programme written in Python. It involves a pre-set random generation algorithm that utilises a set of parameters stating the number of vertices to be 1000. The programme then randomly generates different edges connecting each vertex and thus, creates a random graph. It makes sure that no combination of edges and vertices is repeated more than once.

The algorithm involves the following steps -
1. Importing networkx as nx, a free Python library released under the BSD-new licence which allows the generation of multiple edges connected to multiple vertices in a graph.
2. Setting the pre-set number of vertices of each random graph to 1000 as 'n'.
3. Setting the graph to be generated by nx as a random erdos_renyi_graph under the variable 'g'.
4. Printing the vertices and edges of the graph to create a random graph.
5. Looping the same process until the desired number of 1000 random graphs with 1000 vertices each have been generated.

Adjacency Matrix Generation:

The next step in the process is the generation of adjacency matrices for each random graph, using an algorithm written in Python.

The algorithm involves the following steps -

1. Importing networkx as nx.

2. Importing pyplot as plt from matplotlib. Pyplot is a group of command functions from Matplotlib, a command library in Python used to generate static and dynamic figures.

3. Creating a function for the generation of adjacency matrices under which -

If the two vertices of the random graph are connected by an edge, the adjacency matrix will have the digit '1' printed in that position.

Else, the adjacency matrix will have the digit '0' printed in that position to symbolise no connecting edge between the vertices.

4. Adding the set of vertices and edges of the already generated random graphs under two different variables for each, which will allow the programme to generate the adjacency matrix for each graph.

5. Looping the same process until the desired adjacency matrices for all 1000 random graphs have been generated.

Eigen Value Generation:

The third step of this statistical analysis is the generation of eigenvalues from the random graphs. Each random graph is 1000 vertices and thus, will have 1000 eigenvalues. Such eigenvalues will be generated for all of the random graphs and then arranged in ascending order for their statistical study and histogram generation. Another Python programme will be run for the process.

The algorithm involves the following steps -

1. Importing numpy library as np. Numpy is a Python for adding support for the generation of multi-layered arrays and matrices.

2. Creating a 2-D array in Numpy to generate the respective eigenvalues.

3. Taking values of the adjacency matrices and vertices of the graph under the Python programme in specific variable names.

4. Printing the Eigenvalues by running a Numpy command.

Combination Example:

Let's take a simple example of a generated random graph with 100 vertices, and each edge given with the notation (x,y) where x and y are the two vertices that the edge is connecting.

The next step was to find the adjacency matrix of this random graph, which was once again given by a set of binary zeros and ones, each representing the connections of a vertex with another vertex by a particular edge.

Following this adjacency matrix is the step to find the eigenvalues of this particular matrix. As the random graph generated has 100 vertices, the adjacency matrix of this graph will also have 100 eigenvalues.

Results

When a graph of the desired Eigenvalue distribution is finally produced and generated, it forms a GOE distribution (Figure 3), concurrent with the distribution seen in a wigner surmise (Figure 2). Hence, random matrices generated from randomly generated graphs also show a wigner distribution of their Eigenvalues.
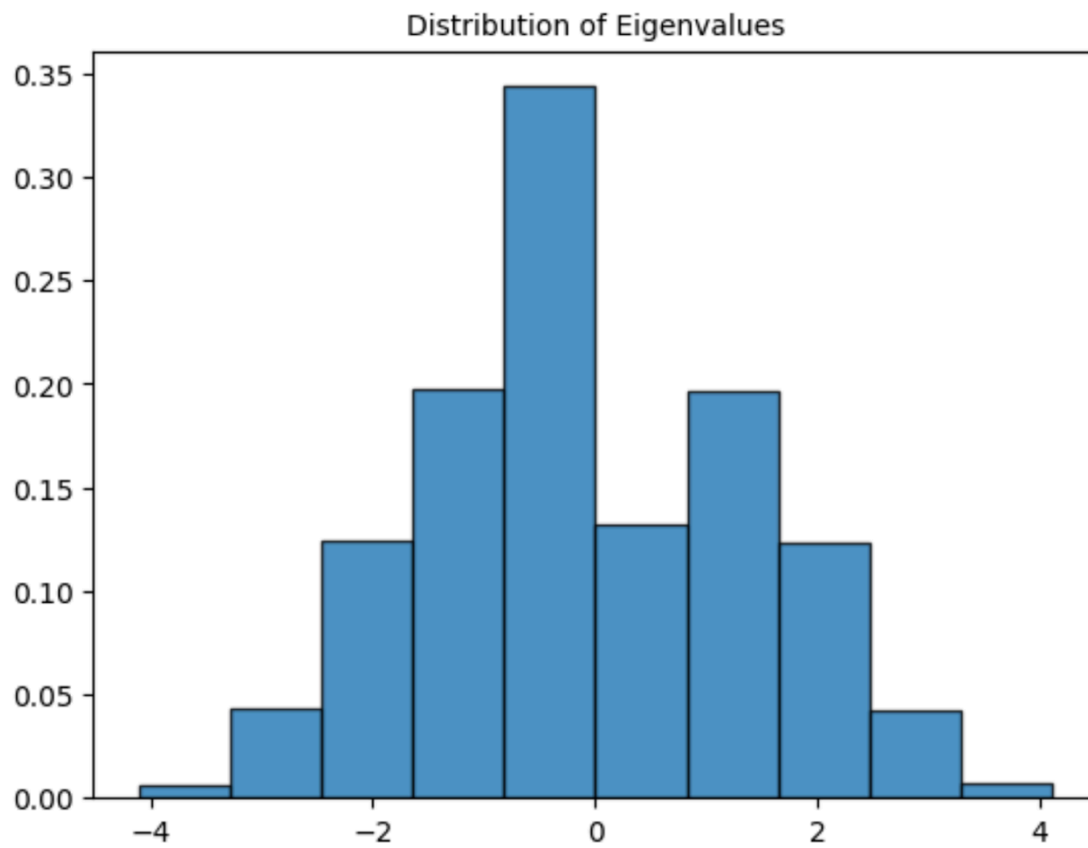
Figure 2: The plot of distribution of eigenvalues of adjacency matrices of randomly connected graphs. 1000000 eigenvalues generated from 1000 randomly connected graphs with 1000 nodes each is used.
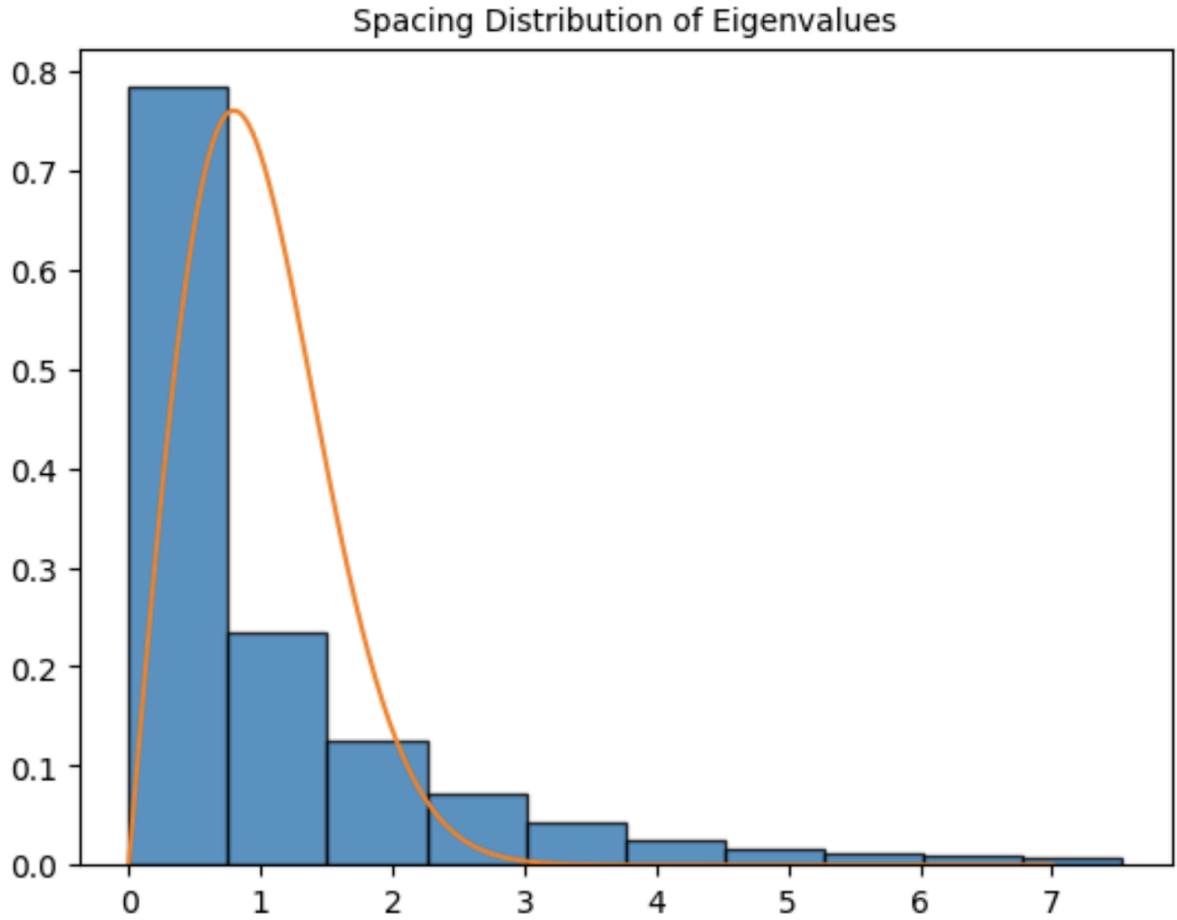
Figure 2: The yellow line represents the GOE distribution function. It can be seen to agree with the spacing distribution with the histogram.

Conclusion

In this work, we explored the relation between random matrices and randomly connected graphs. We studied the eigen-spectrum of the adjacency matrices and found that it agrees with the GOE distribution. This relation opens up a great deal of avenues of studying many body interactions using randomly connected graphs.

Works Cited

1. Bondy, John Adrian, and Uppaluri Siva Ramachandra Murty. *Graph theory with applications*. Vol. 290. London: Macmillan, 1976.

2. West, Douglas Brent. *Introduction to graph theory*. Vol. 2. Upper Saddle River: Prentice hall, 2001.

3. Mondal, Basudeb, and Kajal De. "An overview applications of graph theory in real field." *International Journal of Scientific Research in Computer Science, Engineering and Information Technology* 2.5 (2017): 751-759.

4. Bollobás, Béla, and Béla Bollobás. *Random graphs*. Springer New York, 1998.

5. Kang, Mihyun, and Zdenek Petrasek. "Random graphs: Theory and applications from nature to society to the brain." *Internationale Mathematische Nachrichten* 227 (2014): 1-24.

6. Singh, Harmanjit, and Richa Sharma. "Role of adjacency matrix & adjacency list in graph theory." *International Journal of Computers & Technology* 3.1 (2012): 179-183.

7. Chung, Fan RK. "Eigenvalues of graphs." *Proceedings of the International Congress of Mathematicians: August 3–11, 1994 Zürich, Switzerland*. Birkhäuser Basel, 1995.

8. Doob, Michael. "Eigenvalues of graphs." *Topics in algebraic graph theory* (2004): 30-57.

9. *Adjacency Matrix -- from Wolfram MathWorld*. (n.d.). Adjacency Matrix -- From Wolfram MathWorld. https://mathworld.wolfram.com/

10. *Matrix | Definition, Types, & Facts*. (n.d.). Encyclopedia Britannica. https://www.britannica.com/science/matrix-mathematics

11. *Introduction to Adjacency Matrix For Graphs*. (2023, January 13). Codedamn News. https://codedamn.com/news/programming/introduction-to-adjacency-matrix-for-graphs

12. Milo, Ron, et al. "On the uniform generation of random graphs with prescribed degree sequences." *arXiv preprint cond-mat/0312028* (2003).

13. Tao, Terence. *Topics in random matrix theory*. Vol. 132. American Mathematical Society, 2023.

14. Guhr, Thomas, Axel Müller–Groeling, and Hans A. Weidenmüller. "Random-matrix theories in quantum physics: common concepts." *Physics Reports* 299.4-6 (1998): 189-425.

15. Bohigas, Oriol. *Random matrix theories and chaotic dynamics*. No. IPNO-TH--90-84. Paris-11 Univ., 1991.

16. Edelman, Alan, and N. Raj Rao. "Random matrix theory." *Acta numerica* 14 (2005): 233-297.

17. Sugiyama, Mahito, et al. "graphkernels: R and Python packages for graph comparison." *Bioinformatics* 34.3 (2018): 530-532.

18. Chung, Jaewon, et al. "Graspy: Graph statistics in python." *Journal of Machine Learning Research* 20.158 (2019): 1-7.

The role of HAP1 in the progression of Huntington's disease in middle-aged patients By Ayaan Arif

Introduction

Huntington's Disease (HD) is a rare genetic disease that causes neurodegeneration. This disease is genetically linked and inherited in a dominant manner, however it affects females more than males[1]. There is currently no mechanism elucidated as to why females are affected more than males. (6) HD is an adult-onset disease, with symptoms starting to present at around 40 to 50 years of age. Interestingly, the severity of HD symptoms increases throughout the generations and the age of onset lowers.(7) While HD typically presents in middle aged adults, there is a low chance of a juvenile onset occurring (<21 years old). HD is caused by an enlarged CAG repeat number in the huntingtin gene (HTT) resulting in a polyglutamine repeat on the protein. The HTT gene on chromosome 4 is responsible for the instructions needed to create the huntingtin protein. Healthy individuals typically present with a repeat number less than 26 while affected individuals have a CAG repeat above 40s.(7) While it is known that the enlarged repeat results in HD, the function and exact disease pathway remains unknown. Research has shown that degeneration begins by affecting voluntary movement. While HTT is expressed cytoplasmically in all neurons throughout the brain, the exact regions of the brain that are affected first remain unknown. However, leading hypotheses predict that HD affects the cerebellum and basal ganglia due to their involvement in motor function.(8)

Research on HD has focused on HTT interacting proteins. This includes Fanconi anemia group D2 (FANCD2) and FANCI associated nuclease 1 (FAN1) and Huntingtin associated protein 1 (HAP1). FAN1 is one of many proteins that interact with HTT, and is what many believe to be the most important huntingtin-interacting protein. FAN1 binds to the polyglutamine repeat on the HTT protein to stabilize the repeat number. Without the presence of FAN1, the CAG repeat increases drastically. (5) This suggests that FAN1 is important for lessening the severity of HD. HAP1 is a protein found in neurons and the digestive system and is integral for neuronal survival. (3) Interestingly, while HAP1 has similar localization and density patterns in human versus monkey brains, the onset of HD drastically differs in humans compared to other primates, raising many questions abouts its true functions. HAP1 is also a HTT binding protein. When FAN1 is knocked out and there is a resulting higher CAG repeat, studies show that HAP1 has a higher binding affinity to HTT. This affinity likely plays a role in the progression and/or severity of HD. However, since HAP1 is found in different cell types throughout the body, it likely has multiple cellular functions.

Researchers remain unsure of the exact disease mechanism of HD and how this pathway can cause issues in the central nervous system. Additionally, it remains unknown as to which parts of the brain are affected and the order in which they are affected. However, levels of HAP1, a commonly found protein in the nervous system, has been shown to be correlated to the time of onset of HD. I hypothesize that HAP1 is the causative protein that when interacting with mutated HTT, begins the onset of the disease mechanism cascade. In order to evaluate my hypothesis, I will analyze data from multiple papers on HD and HAP1 interaction with HTT and

compare those results. I hope that the conclusions drawn from this paper will aid in creating a disease mechanism for HD.

Definitions and Literature Review

HD - Huntington's Disease, an autosomal dominant inherited neurodegenerative disease which shows first symptoms at ~40 years old and is fatal 10-30 years after first diagnosis. Onset of HD symptoms starts earlier as the number of generations increases.

HTT - gene that provides instructions for creating the Huntingtin protein.

CAG repeat - Cytosine Adenine Guanine repeats found in HTT. The higher the repeat number, the higher the risk for developing HD.

HAP1 - Huntington's Associated Protein 1, the most studied protein in the HD field and widely hypothesized to be a main catalyst for HD.

FAN1 - FANCI Associated Nuclease 1, a nuclease that plays a role in DNA cross-link repair. This protein has also been found to interact with HAP1.

I used PubMed to begin my initial search finding papers related to HD and the proteins involved, such as HAP1 and FAN1. However, I found that many papers were focused on the genetics of HD and its symptom progression. Thus, I had to narrow down my search to focus on papers that specifically evaluated the relationship and related symptoms between HAP1/FAN1 and HTT (Figure 1).
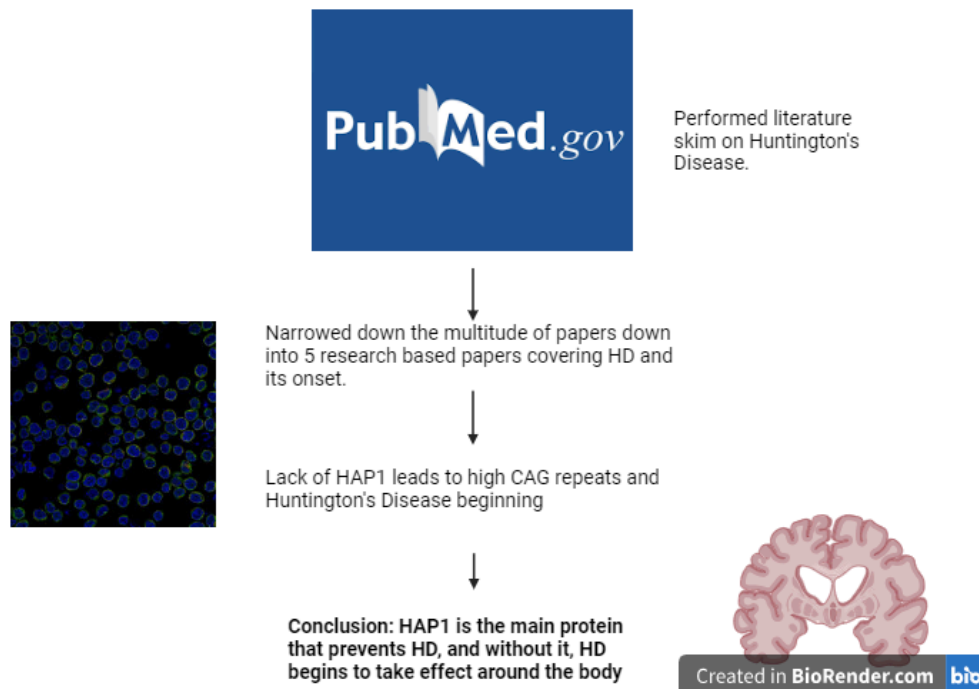
Figure 1. Literature Review: I used Pubmed to research papers involving HD and its onset, then finalized multiple papers into 5 that related specific proteins with their interactions with HTT. Using those papers, I drew a conclusion that HAP1 was the main protein necessary for avoiding HD.

Results

   HTT is expressed throughout all regions of the brain and specifically, in all neuronal and glial cells. Liu et al. 2023 summarized histological evidence showing HTT expression throughout the different brain regions in primate, human, and rodent brains. This showed that there are differential expression patterns of HTT in the different brain regions in humans and monkeys compared to rodents[4]. HAP1 is a protein that is predicted to bind to HTT and affect the cell transport through organelles such as the vesicles, which reduces the amount of nutrients taken to certain areas of the brain. HAP1 binding also is hypothesized to reduce the number of repeat expansions in the HTT gene. HAP1 has been widely studied and is hypothesized to play a role in the onset of HD. Interestingly, when mutant HTT is delivered to monkey and rodent models, the distribution of HTT and HAP1 seemingly plays a role in the progression of HD. Expression and localization of HTT and HAP1 in humans and monkeys is similar, and so is their progression of HD. In contrast, rodents have different expression and localization patterns of HAP1 as well as a different disease progression, indicating that HAP1 could contribute a large amount to HD disease progression (Figure 2 A,B). However, which specific regions of the brain are first affected by HD remains unknown.
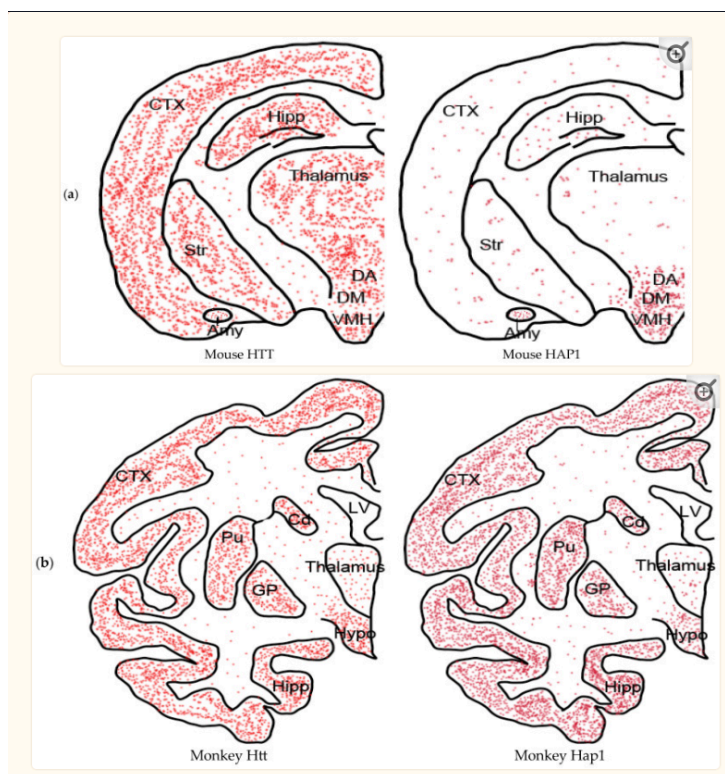
Figure 2. HTT and HAP1 localization in mouse and monkey brains: Images showing the density and localization of HTT and HAP1 in a) mouse brains b) primate brains. Figure taken from Liu et al, 2023.

   Another important gene predicted to be related to HD is FAN1. In Goold et al, the authors hypothesize that a high FAN1 expression is linked to slower progression of HD in affected patients[5]. This was tested by using a transcriptome-wide association study (TWAS) to identify

specific genes that alter the age-at-onset (AAO) of HD. The authors analyzed the transcriptome of 452 diseased human dorsolateral prefrontal cortex samples. The results were analyzed for significance using Bonferroni correction statistics. From these results, authors showed that FAN1 transcription levels are highly associated with AAO of HD. The CAG repeat levels in all areas of the CNS and peripheral nervous system were impacted, showing levels of 100+ CAG repeats, which is 60 over the threshold for HD, showing a late-onset case[5]. Further trends suggest a decrease in FAN1 mRNA levels resulting in an earlier onset of HD. From this data, it can be hypothesized that HD patients have a lower concentration of FAN1 in particular brain regions. However, what causes this lower concentration of FAN1 is unknown.
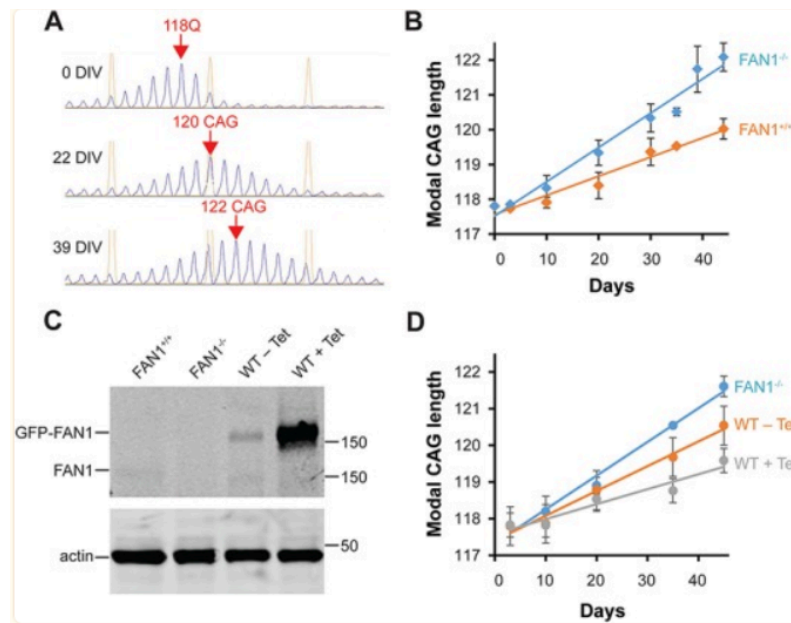
Figure 3. FAN1 expression stabilizes CAG repeat levels: A. Visual representations showing the number of modal CAG repeat levels after cell divisions. CAG repeats greatly increase between 0 and 22 divisions. B. Modal CAG lengths are shown over 40 days in cells with (orange) and without FAN1 (blue). Cells lacking FAN1 have a significant increase in modal CAG length. C. Modal CAG repeat size in cells expressing exon 1 of HTT. Data of 3 replicants for each FAN1[GFP-WT] condition and six for FAN1^{-/-} are shown. Cells lacking FAN1 have the longest CAG length and cells with exon 1 of HTT (gray) have the shortest CAG length. Figure taken from Goold et al, 2018.

An increase of CAG repeats causes instability within the 4th chromosome[1]. This instability affects the HTT gene, which likely begins the onset of HD. Pinto et al. performed comprehensive quantitative analyses of CAG expansion of around 50 central nervous system (CNS) and peripheral nervous system postmortem patients to evaluate the different CAG repeat amounts. This was examined by extracting DNA and determining the stability of the 4th chromosome and comparing it to the number of CAG repeats of the subjects. As seen in Figure 3A, cells lacking FAN1 have high CAG repeats after division, possibly contributing to HD. Additionally, cells lacking FAN1 have an increase in CAG lengths compared to cells with FAN 1 (Figure 3B, C). The authors' results on GeneMapper, an automated genotyping program, showed

higher CAG repeats in similar parts of the brain, further showing that these higher CAG repeats are likely associated with the onset of HD and the severity of its symptoms (Fig 4A,B). Some of these brain regions presenting with high instability include the accumbens and the putamen, both of which are linked to movement. Involuntary movement is another characteristic symptom of HD, further supporting the authors' hypothesis that high CAG repeats are linked to a faster onset of HD.
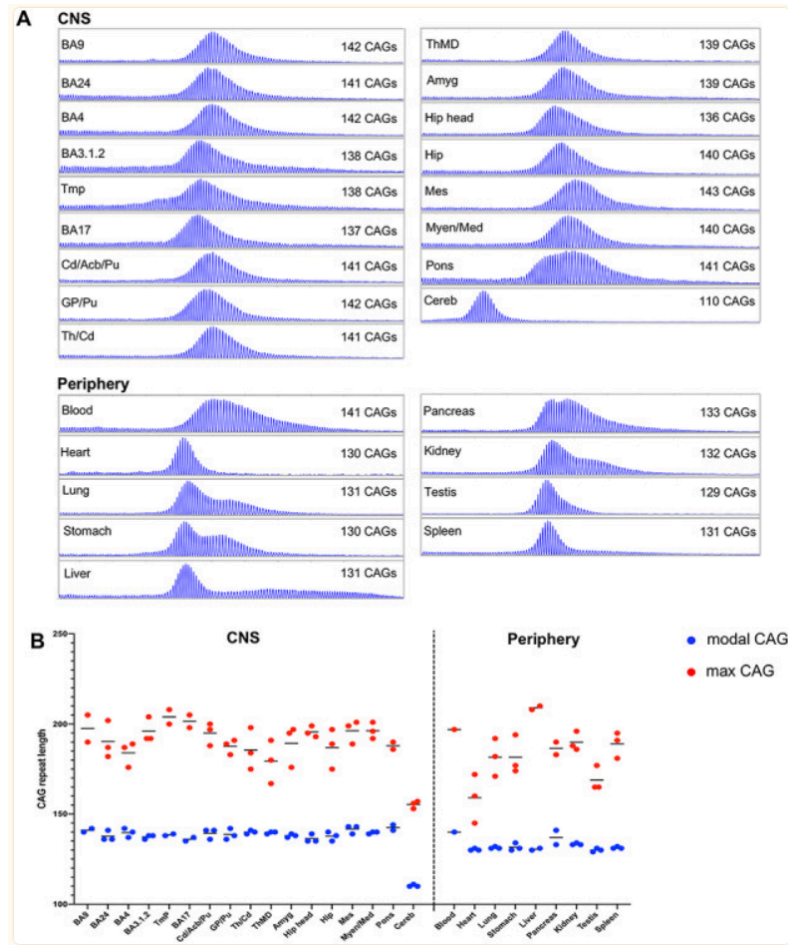

Figure 4. CAG Repeat levels in juvenile-onset HD: A. GeneMapper results from expanded allele HTT products from areas in the nervous system. Cells split up into CNS and PNS locations, repeat number shown for each. B. Modal (blue) and maximum (red) CAG repeats plotted to compare CAG repeat lengths between different cells in the CNS and PNS. Figure taken from Pinto et al, 2020.

Calcium release channels in the CNS play an important role in neuronal signaling and dysfunction of these channels is associated with HD. Tang et al. identified a calcium release channel in neurons, InsP$_3$R1, that complexes with HAP1A and HTT. The authors found that mutated HTT activates InsP$_3$R1 in the lipid bilayer of medium spiny striatal neurons promoting erroneous release of Ca^{2+}. This signaling is hypothesized to quicken cell death within these medium spiny striatal neurons. This theory was tested by studying mice that had targeted disruption of both HAP1 alleles and dissecting the striata from the brains to determine how

mutant HTT interacts with different proteins like InsP$_3$R1 in the brain. They found that HAP1 plays a role, but is not necessary, for the interaction between HTT and InsP$_3$R1 and subsequent Ca^{2+} release. Even in mouse cells without HAP1, the InsP$_3$R1 levels were unaltered, showing HAP1 is not necessary for the interaction between HTT and InsP$_3$R1 (Fig. 5). If the CAG repeat in HTT is long enough, HTT can bind to InsP$_3$R1 without needing HAP1. In HD cases, there is a significant lack of HAP1 within neurons and a large CAG repeat, resulting in excess HTT InsP$_3$R1 binding but not Ca^{2+} release. HAP1 is necessary to alter basal Ca^{2+} levels, even with HTT genes with large expansions. Interestingly, it is hypothesized that erroneous Ca^{2+} levels could be the earliest symptom of HD, supporting HAP1 as a pivotal protein in the onset of HD. Even with these promising results the mechanism for what causes neuronal death in HD patients is still largely unknown and is mostly speculatory as many proteins may be contributing and no disease mechanism has been elucidated.
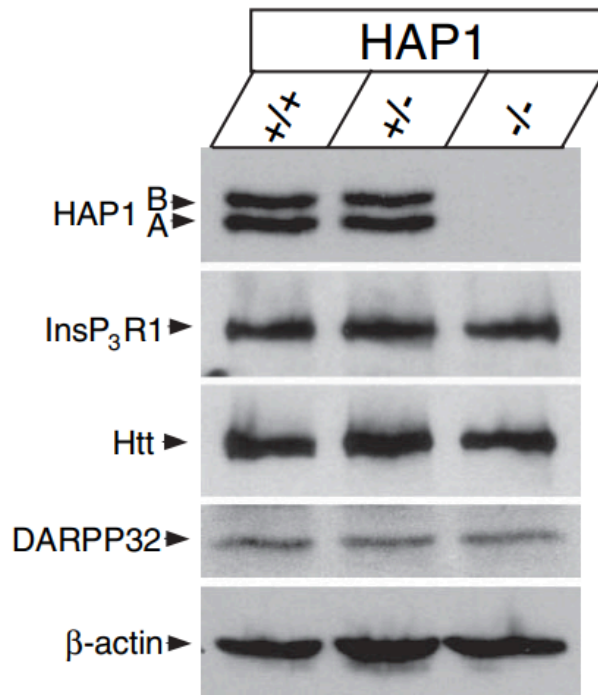
Figure 5. Western Blotting of cultured mice medium spiny neurons (MSNs): 16 MSNs from different HAP1 variants of mice (HAP1 -/-, HAP1 -/+, HAP1+/+) were collected and blots were performed to determine protein concentrations of HAP1, InsP$_3$R1, Htt, DARPP32, and B-actin (control). Figure taken from Tang et al, 2004.

Discussion

Most evidence points to the presence of HD stemming from mutations of certain proteins. Many proteins seem to be attributed to this, such as FAN1 and HAP1. Altered levels of these proteins can cause changing levels of CAG repeats within the Huntingtin gene, which is known to cause HD symptoms. Liu et al. showed that HAP1 was necessary to maintain the number of CAG repeats within HTT. Thus, a decrease or knockout of HAP1 would result in an increase in the number of CAG repeats, implicating it as a potentially HD-causing gene. Similarly, FAN1 has been associated with a slower onset of HD in patients, suggesting a disease mechanism

between FAN1 and HAP1 working together to restrict HD from forming. Tang et al. showed that mutated HTT also binds to calcium release channel InsP$_3$R1, causing unnecessary calcium to be released into cells, resulting in cell death. Excessive cell death will eventually result in organismal death. Interestingly, HD patients present with high Ca^{2+} levels at the beginning of disease onset, which suggests that elevated CA^{2+} levels are an early symptom of HD. HAP1 is also responsible for the interaction between InsP$_3$R1 and HTT. HAP1 seems to be related to most of the relationships between HD and its symptoms. This prevalence leads to the conclusion that HAP1 is the most important protein involved in preventing HD and its onset. This research could be used to possibly slow down HD by theoretically adding new HAP1 proteins into the CNS, thus balancing the CAG repeats. However, it will likely be quite a while until technology makes this idea a reality.

Works Cited

Adlard P. A., Cotman C. W. (2004). Voluntary exercise protects against stress-induced decreases in brain-derived neurotrophic factor protein expression. Neuroscience. 2004;124(4):985-92. doi: 10.1016/j.neuroscience.2003.12.039. PMID: 15026138.

Mouro Pinto, Ricardo, et al. "Patterns of CAG Repeat Instability in the Central Nervous System and Periphery in Huntington's Disease and in Spinocerebellar Ataxia Type 1." Human Molecular Genetics, vol. 29, no. 15, 7 July 2020, pp. 2551–2567, https://doi.org/10.1093/hmg/ddaa139.

Tang, Tie-Shan, et al. "HAP1 Facilitates Effects of Mutant Huntingtin on Inositol 1,4,5-Trisphosphate-Induced Ca2+ Release in Primary Culture of Striatal Medium Spiny Neurons." European Journal of Neuroscience, vol. 20, no. 7, Oct. 2004, pp. 1779–1787, https://doi.org/10.1111/j.1460-9568.2004.03633.x. Accessed 12 Dec 2023.

Liu, Li, et al. "Huntingtin Interacting Proteins and Pathological Implications." International Journal of Molecular Sciences, vol. 24, no. 17, 22 Aug. 2023, pp. 13060–13060, doi.org/10.3390%2Fijms241713060, https://doi.org/10.3390/ijms241713060.

Goold, Robert, et al. "FAN1 Modifies Huntington's Disease Progression by Stabilizing the ExpandedHTTCAG Repeat." Human Molecular Genetics, vol. 28, no. 4, 24 Oct. 2018, pp. 650–661, https://doi.org/10.1093/hmg/ddy375.

Zielonka, Daniel, and Barbara Stawinska-Witoszynska. "Gender Differences in Non-Sex Linked Disorders: Insights from Huntington's Disease." Frontiers in Neurology, vol. 11, 7 July 2020, https://doi.org/10.3389/fneur.2020.00571.

Caron, Nicholas S., et al. "Huntington Disease." PubMed, University of Washington, Seattle, 1993, www.ncbi.nlm.nih.gov/books/NBK1305/#:~:text=Anticipation.

Reiner, Anton, et al. "Genetics and Neuropathology of Huntington's Disease." International Review of Neurobiology, vol. 98, 2011, pp. 325–372, www.ncbi.nlm.nih.gov/pmc/articles/PMC4458347/, https://doi.org/10.1016/b978-0-12-381328-2.00014-6.

Developing a Line by Line Code Translator: Classification NLPs By Heesuh Hannah Kim, Taehyun Alex Inn

Abstract

The significance of artificial intelligence has grown exponentially in recent years. With the recent surfacing of Chat GPT and other similar AI platforms, AI has become ubiquitous in our lives. One of the fundamental technologies used in AI and machine learning is natural language processing.

This study on natural language processing(NLP) aims to unravel the mechanisms on how computers are able to process human text, transforming it to numerical values, thus exploring human-AI relationships.

To accomplish this, a neural network model will be used as the backbone of our machine learning model. This model will serve as the bridge between human generated inputs and numerical representations that can be understood by the computer. This study explores various techniques often used for NLP as well.

Our results show the various ways a computer can effectively understand human language and return wanted outputs. The result code displays the practical aspects of AI in our daily lives, and offers insight to the way AI can improve the way we communicate. As we delve into the intricacies of human language and machine comprehension, the study contributes to a broader understanding of the symbiotic relationship between humans and AI and paves the way for more sophisticated communication technologies in the future.

The intersection of natural language processing and computer programming presents a proliferating ground for innovations that can significantly enhance learning outcomes for students on their coding journey.

Producing the Dataset

To build the program, the first thing done was making a dataset. The dataset was made with chat GPT, by explaining the format of the data set and giving examples to it. Chat GPT was able to create a dataset with one hundred natural languages that represent a+b. The dataset will include prompts like "Add a and b," "Summation of a and b," "Add the value of b to a," etc. Since there are infinite ways to express a+b, we cannot make a perfect dataset. However, since we are building a machine learning program, we only need enough prompts in the dataset for our program to analyze and learn from. Using Chat GPT, we created a datafile with 221 possible prompts the program could learn from. To train the machine which ones are natural languages for a+b and which ones are not, not only the examples of natural languages of a+b was added, but also natural languages of multiplication, division, and subtraction of two or more variables were added to the dataset with a different label. These included "calculate the product of two numbers" and "divide the number a by b." To differentiate the correct prompts and the wrong ones, we added a binary label to each prompt, giving the value 1 to the prompt correctly describing a+b, and the value 0 to those not. Therefore, the final dataset had two columns: one for the prompt and the other for its binary label.

The first 5 rows of the dataset used are inserted below. The full file can be found in the appendix.

Prompt	Label
'print out the value of c where c is the sum of a and b'	1
'show the sum of two numbers a and b'	1
'calculate the product of two numbers'	0
'add a and b and display the result'	1
'Find the sum of a and b'	1

Figure 1: Prompt examples used for machine training

With the dataset made, now the code has to be built to use the dataset. The code first starts with dividing the dataset into two: labels and prompts. This is done to access each section of the dataset conveniently. Using pandas to read the dataset, the prompts were put into the array X and the binary labels into y.

```
df = pd.read_csv('/content/Dataset (1).csv')
X = df['prompt']
y = df['label']
```

TF-IDF Features

With the dataset opened and stored, the program needs to evaluate the importance of certain words such as "addition" and "sum", so the TF-IDF feature extraction is used. TF-IDF(Term Frequency - Inverse Document Frequency) is a process of scoring each word by the frequency of the words in the dataset. In this code, a vectorizer is created, which has the TfidfVectorizer function, imported from sklearn.feature_extraction.text, calculating the TF-IDF score. Then the TF-IDF values of X, the array of prompts, are calculated and stored in the array X_tfidf.

```
vectorizer = TfidfVectorizer(max_features=10000)
X_tfidf = vectorizer.fit_transform(X).toarray()
```

The TF of a certain word is calculated by dividing the number of appearances of the word by the total number of words in the dataset, and IDF is calculated by the log of the total number of the documents; which in this case are the each prompt, divided by the amount of the prompts that contains the specific word. Then, the TF-IDF scoring is calculated by multiplying the two values: TF and IDF. This value shows the importance of the words. Words that frequently appear

in a single prompt have higher importance, which is shown by the TF value. However, words that frequently appear in every prompt have lower importance since they might be variable names, conjunctions, or determiners. This is shown by the IDF value. The TF-IDF scoring plays a crucial role in the whole code, as it makes up both the training and the testing dataset that is used to form a neural network. In order to make the model more reliable, splitting of the dataset into training and testing sets is needed. The training set will be used for the model to learn from and adjust its parameters to improve accuracy, and the testing set will be used to assess its performance and accuracy.

X_train, X_test, y_train, y_test = train_test_split(X_tfidf, y, test_size=0.2, random_state=42)

In this code, the division of both the X set and the y set happens. The test size is set to 0.2, giving 80% of the data to the training set, and 20% of the data to the testing set. We also used random_state=42, to ensure some randomness when cutting the dataset into two parts. This also ensures that the X set and y set are shuffled in the same way to prevent any misalignment of a prompt and its label.

One Hot Encoding

The y training and testing set contains the labels for the x training and testing sets, which contains the TF-IDF scoring of the prompts. The two sets of data are converted into one hot encoding. One hot encoding is a way of processing categorical data or data that cannot be arranged in a certain order. Since the neural network model used later in the code requires numerical input, to one-hot encoding the binary categorical values is necessary. In one hot encoding, categorical data is converted into multidimensional vectors. The dimension depends on the number of categories. Since the dataset has only 2 categories (0 and 1), the result will have a 2D array. Then, for each data value, the column that corresponds to the value is set to 1 and all the other columns are set to 0.
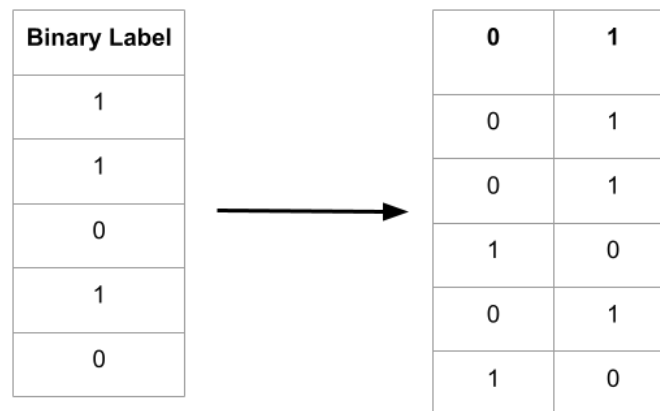
Binary Label
1
1
0
1
0

0	1
0	1
0	1
1	0
0	1
1	0

Fig 2: Visual of One-Hot Encoding

Using the NumPy function np.eye(2), a 2 by 2 matrix is created to store the one-hot encoded values for both the training and test sets.

```
y_train_onehot = np.eye(2)[y_train]
y_test_onehot = np.eye(2)[y_test]
```

One hot encoding is especially used in neural network systems because the binary language used provides a clear representation to the neural network for it to easily work with.

Tensorflow Neural Network Model

The next section is the most important part of the code. It is building a neural network model with tensorflow's keras API. A neural network is a simplified model of the human brain, with layers representing neurons. Each layer has a specific function and works with other layers to enable the learning process. The three main parts of the network are the input layer, hidden layer, and output layer. These layers are connected by weights, which are the parameters that the model learns during training. The neural network learns by examining each prompt in the training set and predicting the result. When the predicted result is incorrect, the model adjusts its parameters, improving its accuracy. Thus, an efficient model that is able to learn from datasets and correct itself is created.

```
model = tf.keras.Sequential
```

For this model, tf.keras.Sequential from TensorFlow will be used to create a linear stack of layers. The various layers, such as convolutional, recurrent, and LSTM, will then be added to the model.

Input Layer

The model starts with the input layer of the neural network.

```
tf.keras.layers.Dense(512, activation='relu', input_shape=(X_train.shape[1],))
tf.keras.layers.BatchNormalization()
```

In this code, the shape of the input data is set to X_train, which is the training set of prompts. The first number 512 represents the unit parameter, or the number of neurons. In dense layers, a higher number of neurons represents a larger capacity for the layer to learn the patterns in the input data. The activation is set to 'ReLu.' ReLU is an abbreviation of Rectified Linear Unit. It is a function that turns all the negative input to zero, and leaves the positive inputs as it is. There are other activation functions such as Sigmoid or Tanh, but they do not deal with the vanishing gradient problem like ReLu does.

The vanishing gradient problem happens during the backpropagation process. The backpropagation process is propagating the difference of the target value and the calculated output to the back, updating the variables each node has. When the two functions' derivative values are continuously powered, as the backpropagation process gets further from the output layer, the gradient value becomes smaller and smaller, eventually "vanishing." This causes the two functions, Sigmoid and Tanh, to not have the model to be trained properly.

However, the ReLU activation function is a solution to the vanishing gradient problem. By using the ReLU function, all the positive input's derivative value becomes 1, as the function

does not change the value of the positive input, but changes all the negative inputs into zero. Since the derivative function does not decrease, it solves the vanishing gradient problem.

However, this may cause another problem called dying ReLU. Since all the negative values are converted into zero when it is turned into a derivative function, it is difficult to revive the negative values that have already turned into zero. The ReLU function is also faster in calculating due to its simple function rather than the complex, long calculations the Sigmoid and Tanh functions use.

The input layer is then normalized via batch normalization. Batch normalization works by adjusting and rescaling the activations of each layer in a neural network during training, ensuring that the mean activation is close to zero and the variance is close to one, which helps stabilize and accelerate the training process. Batch normalization enhances stability, speed, and performance, which is the reason why it is treated as a key component in deep learning models.

Hidden Layers

In the next section, two hidden dense layers are created with each 512 and 256 neurons used, ReLU activated, and are regularized by the L2 regularizer method.

```
tf.keras.layers.Dense(512, activation='relu',
        kernel_regularizer=regularizers.l2(0.001))
tf.keras.layers.Dropout(0.5)
tf.keras.layers.Dense(256, activation='relu',
        kernel_regularizer=regularizers.l2(0.001)
tf.keras.layers.BatchNormalization()
```

Regularization is used to prevent overfitting in machine learning. Overfitting happens when the model is trained for too much, or when the model is too complex. The model will start learning noises, which are data that are non-related to the main topic, and become too similar to the sample dataset provided. This results in the inability to generalize new data, which stops the model from being able to accomplish its purpose such as organizing or predicting data. There are two most common regularizers, L1 and L2, but the regularizer used in this code is the L2 method. The L2 regularizer prevents overfitting by penalizing large weights, which stops the weights from growing too large. Then, the dropout regularization and batch normalization is used, to further regularize the model, and achieve improved performance. Having these hidden layers allows the network to learn hierarchical representation, and adds non-linearities and complex functions to the model. From having multiple layers, the quality of generalization of the model also increases.

Convolutional Layers

The convolutional layers section exists to apply convolutional neural network to national language processing. The convolutional neural network (CNN) was built for areas like computer vision. When dealing with images, the CNN works by sliding a window across the image,

calculating the average of the nearby pixel values to make the image blurry.
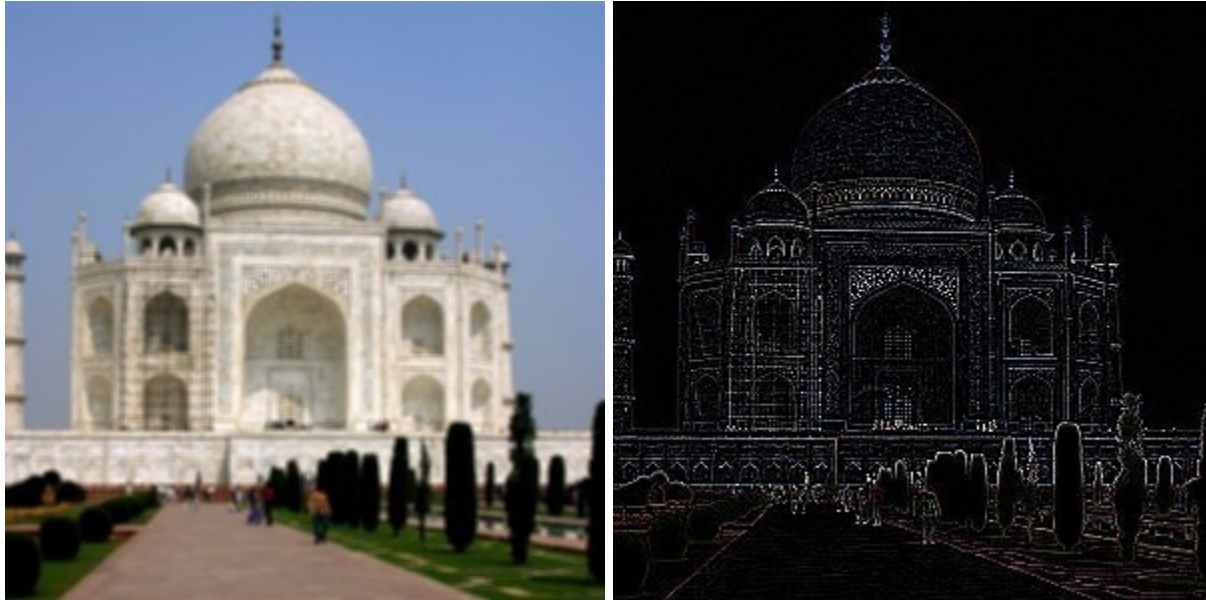

Fig 3: Visual of the CNN

Then, it calculates the differences between the nearby pixels to find edges of the image. Similarly in natural language processing, a filter matrix is used to capture local patterns. The process of convolutional neural network is very fast, which is why it is used in the code. In this code, the convolutional layer section starts by reshaping the model into 2 dimensional. Then it goes through the convolutional layer that each has 64 and 128 filters, with 3 by 3 kernel size. After going through the convolutional layer, the model goes through max-pooling layers to reduce the spatial dimensions of the model while retaining important information. Finally, the layer is flattened into 1 dimensional.

```
tf.keras.layers.Reshape((16, 16, 1))
tf.keras.layers.Conv2D(64, (3, 3), activation='relu')
tf.keras.layers.MaxPooling2D(2, 2)
tf.keras.layers.Conv2D(128, (3, 3), activation='relu')
tf.keras.layers.MaxPooling2D(2, 2)
tf.keras.layers.Flatten()
```

LSTM Layer

LSTM (Long Short Term Memory) is a solution for the problem of long term dependency which happens in other algorithms like RNN (Recurrent Neural Network), which is a problem where the first few data in a dataset is relatively less recognized than other data. To fix this problem, LSTM adds a memory cell that contains an input gate, a forget gate, and an output gate. This improves the network's ability to recognize data that are further away. The forget gate determines which information from the previous memory cell to forget, the input gate determines which values to update and store in the memory cell, and the output gate determines which part of the memory cell to output as the hidden state.

A normal layer in the neural network model works by getting input from a previous step and giving outputs to the next step. However, a bidirectional LSTM layer can work in both ways, receiving input from both the past and future in terms of sequential data. As a result, gradients can flow through the model more effectively and they do not disappear, mitigating the vanishing gradient problem.

```python
tf.keras.layers.Reshape((128, -1))
tf.keras.layers.Bidirectional(LSTM(64, return_sequences=True))
tf.keras.layers.Bidirectional(LSTM(32))
```

In this code, the input is first reshaped accordingly and goes through the first bidirectional layer, which returns an output for each input sequence(return_sequence=True). This allows the model to retain all the information. The second bidirectional layer returns only one output that summarizes the information captured.

Additional Dense Layers

After the additional layers, more dense layers are added. This is done with the same method of adding the hidden layers, but with less neurons. This addition of dense layers increases the complexity and expressive power, being able to learn more and more abstract and high level represented input values. Having more dense layers improves the ability to extract relevant data, capture more complex patterns, and can act as a regularizer from reducing the capacity of the network to prevent overfitting.

```python
tf.keras.layers.Dense(128, activation='relu')
tf.keras.layers.Dropout(0.4)
tf.keras.layers.Dense(64, activation='relu')
tf.keras.layers.BatchNormalization()
```

Output Layer

The output layer's number of neurons corresponds to the number of classes in the dataset, which is 2 in this code. Each of the neurons represents each of the classes, and their output values represents the probability of the input being in the category. The softmax function converts the raw output scores into probabilities, making sure that they sum up to 1. It helps distinguish between low and high predictions, while simple normalization will have the same probability if the proportion between the values is the same. This makes it appropriate for multiclass problems. Softmax function is also not expensive computationally, making it more valuable to be used. The output layer produces the final prediction of the organization of the input by selecting the class with the highest possible probability. This is how the model can make successful guesses on which category the input should be in.

```python
tf.keras.layers.Dense(2, activation='softmax')
```

Compiling and Training of the Model

After the programming of the model, it is now compiled and trained. The compiling is divided into 3 sections: Optimizer, Loss, and Metrics. The optimizer updates the model's weights

corresponding to the gradient of the loss function, to minimize the loss and improve the efficiency during the training.

```
model.compile(optimizer='adam',
        loss='categorical_crossentropy',
        metrics=['accuracy'])
```

The optimizer used in this code is Adam, which is efficient and effective in a wide range of tasks, and helps adapt learning rates during training. The loss of function is calculated by 'categorical crossentrophy' since our data input was categorical. The loss function measures the discrepancy between the predicted probability and true probability distribution of classes and penalizes incorrect predictions in the model to guide the training process by providing feedback to adjust the model's parameter. The categorical cross-entropy is a common loss function which is used in multi-class classification with one-hot encoded input values. The accuracy metric also provides feedback to the model based on its measuring of the proportion of the correctly predicted sample out of the total number of samples.

Then, the model is trained, starting from the code model.fit().

```
model.fit(X_train, y_train_onehot, epochs=100, batch_size=5)
```

The function is provided with the X_train set and y_train_onehot set, amount of epochs and batch size. The two training sets provide the prompt and the labels; classes, of the dataset. During the process of training, the model updates its parameters using the backpropagation and the optimizer used to compile the model. The amount of epochs means the amount of training. In every epoch, the model makes predictions, computes the loss, and adjusts the model's parameters according to the feedback received. The batch size represents the number of samples used in each iteration of training to update the parameters of the model. By specifying the batch size, the training process can be done in a more efficient way, since it allows the model to process smaller chunks of data rather than processing a large data in a whole. The number of epochs was set to 100, and the batch size was set to 5 in the first program.

Using the Neural Network Model

Now the neural network model is coded, compiled, and trained, it is now able to be used. The generate code function uses the neural network model to output an appropriate answer to an input given. The function receives a text value as its parameter, then transformed through a TF-IDF vectorizer, just as how the training dataset was converted into TF-IDF representation. This allows the function to use the neural network to make predictions. The prompt is sent to the neural network model to predict the probability of the prompt belonging to a certain class. With the prediction probability, thresholding happens to output correct values according to the predicted class the input belongs to. In this code, if the predicted probability is higher than 0.5, the code returns a code that displays a+b, and if it is lower than 0.5, the code returns 'Sorry, I am not yet able to write the code you want me to write.' The next few lines are just simply grabbing the input from the user and displaying the result from the function.

Final Code

To implement the code, necessary libraries such as pandas, NumPy, TensorFlow and sci-kit learn are needed.

Then, putting the code together and adding a while loop for user inputs, we get the final code.

```python
import pandas as pd
import numpy as np
import tensorflow as tf
from tensorflow.keras.layers import Dense, Dropout, BatchNormalization, Conv2D, MaxPooling2D, Flatten, LSTM, Bidirectional
from tensorflow.keras import regularizers
from sklearn.feature_extraction.text import TfidfVectorizer
from sklearn.model_selection import train_test_split

df = pd.read_csv('/content/Dataset (1).csv')
X = df['prompt']
y = df['label']

vectorizer = TfidfVectorizer(max_features=10000)
X_tfidf = vectorizer.fit_transform(X).toarray()

X_train, X_test, y_train, y_test = train_test_split(X_tfidf, y, test_size=0.2, random_state=42)

y_train_onehot = np.eye(2)[y_train]
y_test_onehot = np.eye(2)[y_test]

model = tf.keras.Sequential([
  # Input Layer
  tf.keras.layers.Dense(512, activation='relu', input_shape=(X_train.shape[1],)),
  tf.keras.layers.BatchNormalization(),

  # Hidden Layers with different configurations
  tf.keras.layers.Dense(512, activation='relu', kernel_regularizer=regularizers.l2(0.001)),
  tf.keras.layers.Dropout(0.5),
  tf.keras.layers.Dense(256, activation='relu', kernel_regularizer=regularizers.l2(0.001)),
  tf.keras.layers.BatchNormalization(),

  # Convolutional Layers Example (assuming the input is reshaped appropriately)
  tf.keras.layers.Reshape((16, 16, 1)),  # Reshaping to 2D for convolution
  tf.keras.layers.Conv2D(64, (3, 3), activation='relu'),
  tf.keras.layers.MaxPooling2D(2, 2),
  tf.keras.layers.Conv2D(128, (3, 3), activation='relu'),
  tf.keras.layers.MaxPooling2D(2, 2),
```

```python
    tf.keras.layers.Flatten(),

    # Bidirectional LSTM Layer
    tf.keras.layers.Reshape((128, -1)),  # Reshaping for LSTM layer
    tf.keras.layers.Bidirectional(LSTM(64, return_sequences=True)),
    tf.keras.layers.Bidirectional(LSTM(32)),

    # More Dense Layers
    tf.keras.layers.Dense(128, activation='relu'),
    tf.keras.layers.Dropout(0.4),
    tf.keras.layers.Dense(64, activation='relu'),
    tf.keras.layers.BatchNormalization(),

    # Output Layer
    tf.keras.layers.Dense(2, activation='softmax')
])

model.compile(optimizer='adam',
        loss='categorical_crossentropy',
        metrics=['accuracy'])

model.fit(X_train, y_train_onehot, epochs=100, batch_size=5)

def generate_code(prompt):
    transformed_prompt = vectorizer.transform([prompt]).toarray()
    prediction = model.predict(transformed_prompt)

    if prediction[0][1] > 0.5:
        numbers = [int(word) if word.isdigit() else None for word in prompt.split()]
        numbers = [num for num in numbers if num is not None]

        if len(numbers) == 2:
            a, b = numbers
            result = a + b
            return result
        else:
            return "Invalid input format. Please provide two numeric values in the prompt."

    else:
        return "Sorry, I am not yet able to write the code you want me to write"
```

```python
while(1):
  a = input()
  print(generate_code(a))
```

Testing the Code

        Because the code uses a while loop and allows for user generated prompts, we are able to test the code using different types of prompts.

        Given the correct input format, the model accurately returns the sum of two values a and b.

calculate 3 + 5

1/1 [==============================] - 1s 1s/step

8

find the sum of 2 and 10

1/1 [==============================] - 0s 26ms/step

12

add 5 to 6

1/1 [==============================] - 0s 25ms/step

11

        Given a prompt unrelated to the sum of two integers, the model is able to differentiate it and return "Sorry, I am not yet able to write the code you want me to write."

what is the product of two numbers 3 and 4

1/1 [==============================] - 0s 25ms/step

Sorry, I am not yet able to write the code you want me to write

subtract 7 from 10

1/1 [==============================] - 0s 47ms/step

Sorry, I am not yet able to write the code you want me to write

        Lastly, if the prompt correctly asks for addition, but does not contain exactly two

numbers, the code returns "Invalid input format. Please provide two numeric values in the prompt."

add 5

1/1 [==============================] - 0s 25ms/step

Invalid input format. Please provide two numeric values in the prompt.

Accuracy of the Code

        After a few tests done with different amounts of epochs each time, the result was that the more epochs you go through, the code becomes more and more accurate, however too much of it

327

may cause the model to overfit. The first test was done with 10 epochs, which gave very inaccurate answers to the input provided. The model was able to give the code when natural languages of a+b were given, but it also gave the code to other inputs. For example, inputs such as multiply a and b, a*b, and divide a with b, all gave the code away. When testing with 500 epochs, the results were much better. The model was able to give some accurate responses, but was still not always accurate. It gave correct responses when inputs similar to the dataset such as 'calculate product of two numbers', 'division of two numbers', and 'product of two numbers', but gave wrong answers to modified prompts such as 'multiply a and b', 'divide a to be', and 'subtract a and b'. Until this point, it seemed like the model displayed more accuracy as the amount of epoch increased. However, when the model was trained with 1000 epochs, with every input put in the code from natural languages of a+b to a random sentence, the model did not display the code. This indicates that the model has overfitted the dataset given. The model has focussed on the prompts with the label 0 on too much during the training, resulting in the situation of not giving the code even when the correct natural language was given. Due to this, the amount of epochs plays a significant role in creating an accurate neural network model.

The quality & training speed of the model's correlation with the processing power of the computer

As mentioned above, the amount of epoch is very important to have an accurate model. The time it takes to train the model differs from the hardware accelerator used. Arun with CPU took about 5 to 7 seconds to epoch once, while the T4 GPU only took about 1 second to epoch once. This information shows that only from using the T4 GPU instead of CPU, the model can epoch about 6 times more in the same time duration. There is a reason why a GPU is faster than a CPU. A GPU uses parallel processing, which means that tasks are divided into smaller subtasks, which are distributed among the processor cores in the GPU, resulting in a faster process. On the other hand, a CPU is a processor that processes basic functions of a computer. Its processor core's power is very strong, but there are few of them in a CPU. Originally, there was only one core in a CPU, while CPUs now have multiple of them. Even though there are now more processor cores in a CPU, the CPUs are still less efficient in parallel processing, which means that they are meant to perform sequential tasks quickly, but not for computing multiple processes concurrently. Unlike a CPU, a GPU can compute multiple tasks simultaneously with much faster speed. Neural networks work with large amounts of datasets to make more precise models. This is the reason why a GPU can epoch at a much faster speed than a CPU. Also in GPU, the processing power differs from the GPU used.

Strengths

The written code had many strengths that allowed the model to process data and learn efficiently. First, the techniques used were very fit for the purpose of NLP. The use of TF-IDF feature and one-hot encoding allowed the processing of prompts into numerical values, and a multi-layered neural network model was a good choice, since it allowed for adjustments to the model and the improvement of accuracy. Second, it allows for user input and returns the wanted value, which shows its practicality. This demonstrates how AI really helps humans in real world

scenarios. Third, regularization techniques were used in the layers of the neural network model, which greatly stabilized the model and prevented overfitting, thus improving performance on unseen test data.

Weaknesses

Despite its strengths, our model contains some limitations as well. Most notably, the given dataset is limited and therefore, the model can only learn and adjust to a certain level. Given a totally unprecedented prompt, it may fail to give the correct answer. Also, despite having tested the accuracy of the training set, the test set that was set for validation was not directly implemented in the code. Lastly, there are limitations to the accuracy of the model. The epoch size was set to 100, and the batch size at 5, but to ensure better performance, a higher epoch size is needed for further testing and the batch size also needs to be tested at different sizes. However, even if these values are perfected, the model will still not have perfect accuracy due to the limited dataset.

Further Improvements

We can further improve this code by experimenting with hyperparameters and adding more methods of evaluating the model's performance.

First, it is important to note that adjusting hyperparameters such as the epoch and batch size may change the learning rate and accuracy. Therefore, we shall first change the batch size to 100 while keeping the epoch size constant to look for any change.

When the batch size was set to 100, we could see that the time it took to train was significantly shorter and the accuracy was also shown to be 100% for many epochs.

```
Epoch 95/100
2/2 [==============================] - 0s 26ms/step - loss: 0.2106 - accuracy: 1.0000
Epoch 96/100
2/2 [==============================] - 0s 30ms/step - loss: 0.2075 - accuracy: 1.0000
Epoch 97/100
2/2 [==============================] - 0s 26ms/step - loss: 0.2048 - accuracy: 1.0000
Epoch 98/100
2/2 [==============================] - 0s 29ms/step - loss: 0.2022 - accuracy: 1.0000
Epoch 99/100
2/2 [==============================] - 0s 26ms/step - loss: 0.1996 - accuracy: 1.0000
Epoch 100/100
2/2 [==============================] - 0s 25ms/step - loss: 0.1970 - accuracy: 1.0000
```

However, when the code was tested using user generated prompts, it was not able to return the correct output.

```
calculate 2 + 5
1/1 [==============================] - 1s 1s/step
```

Sorry, I am not yet able to write the code you want me to write
sum of 7 and 9
1/1 [==============================] - 0s 24ms/step
Sorry, I am not yet able to write the code you want me to write

This is because when the batch size is set to 100, there are only 2 sets of data tested for each epoch, since there were only about 230 prompts in the dataset. This greatly compromises the model's ability to learn through multiple runs and tests.

Next, the batch set was set back to 5, but the epoch size was changed to 10.

Epoch 7/10
36/36 [==============================] - 1s 23ms/step - loss: 0.8135 - accuracy: 0.9034
Epoch 8/10
36/36 [==============================] - 2s 43ms/step - loss: 0.8136 - accuracy: 0.8920
Epoch 9/10
36/36 [==============================] - 1s 29ms/step - loss: 0.7950 - accuracy: 0.9489
Epoch 10/10
36/36 [==============================] - 1s 23ms/step - loss: 0.6910 - accuracy: 0.9205

The accuracy was significantly lower and the model did not respond well to user generated prompts.
what is 2 + 5
1/1 [==============================] - 1s 1s/step
Sorry, I am not yet able to write the code you want me to write
3 + 5
1/1 [==============================] - 0s 24ms/step
Sorry, I am not yet able to write the code you want me to write

By experimenting with these values, we can find the perfect hyperparameters for this model that ensures the highest quality performance.

Next, we can use the test sets that we made to evaluate the performance of our model after training. We can add the following code for that purpose, which will return both the loss value, which we aim to minimize, and the accuracy value, which we aim to maximize.

```
test_loss, test_accuracy = model.evaluate(X_test, y_test_onehot, verbose=0)
print(f"\nTest Set - Loss: {test_loss:.4f}, Accuracy: {test_accuracy:.4f}")
```

After running the model with a batch size of 5 and an epoch size of 1000, we got the following:
Test Set - Loss: 0.6795, Accuracy: 0.6667

This accuracy is relatively low compared to the desired one, which could be due to a number of reasons. First, the limited number of data could have led to insufficient training; therefore, more training prompts should be created and added to our data set. Second, despite our efforts at preventing overfitting, the model may have become overfitted to the training set, since the accuracy for the training set was extremely high, almost close to 1. Therefore, we can implement more techniques to prevent this problem, such as more regularization and early stopping.

To further improve the code and expand our knowledge of AI and NLP, other methods of text vectorization can also be explored. Word2Vec and GloVe are other popular NLP techniques that involve the processing of text into vector spaces. We can also refine the layers in our neural network model so that it can handle more complex data as well.

Overfitting/Underfitting: The Ideal amount of Epochs

Going through too large amounts of epochs results in overfitting, while going through too small amounts of epochs results in underfitting. These concepts were explained in previous paragraphs, but in this section, a more descriptive explanation will be given. Finding the ideal amount of epochs is crucial to create a reliable, precise neural network model. Multiple tests were done to figure out the ideal amount of epochs for this model. As said before, a neural network model with 500 epochs wasn't accurate enough. However, unraveling the answer of how much epochs is too large to be used was difficult.

How this Technology can be Used in Various Areas of Study

Natural language processing is a powerful technology, especially in times like this when the power of AI and machine learning is growing in speed. NLP is needed when giving a machine the ability to naturally and humanly converse with a human being. This technology is being used in various fields of study that require a machine to have human conversation or even just have to understand human language. The natural language processing program described in this document focuses on supporting students learning how to program. This code itself is just an example of how the technology can be used in learning how to program. As explained above, the code that is shown on this document only senses natural language for a+b, but the bigger idea is making a code that can generate codes based on what the user input asks for. This program can be connected to other structure planning tools like flow charts, to enhance the student's understanding of programming. The program will be a guiding tool for programmers to learn how to adapt their structure planned with words into a computer language. This kind of artificial intelligence is flexible enough to be used in any area since natural language is used everywhere where a human exists. For example, in fields of study like construction, a NLP might be able to create 3d models or blueprints according to the verbal/textual request, in areas like music industry, a NLP might be used to find or generate perfect sounds the user has requested for, or even right now, in humans daily life, NLP is being used with home speakers like Alexa or Siri, to enhance human's experience in life.

Works Cited

baeldung, "One-Hot Encoding Explained." *Baeldung on Computer Science*, 16 June 2023, Accessed 11 Feb. 2024. www.baeldung.com/cs/one-hot-encoding.

Brownlee, Jason. "How Do Convolutional Layers Work in Deep Learning Neural Networks?" *MachineLearningMastery.Com*, 16 Apr. 2020, Accessed 11 Feb. 2024. https://machinelearningmastery.com/convolutional-layers-for-deep-learning-neural-networks/

Dumane, Govinda. "Introduction to Convolutional Neural Network (CNN) Using Tensorflow."*Medium*, Towards Data Science, 19 Mar. 2020, towardsdatascience.com/introduction-to-convolutional-neural-network-cnn-de73f69c5b83.

Karabiber, Fatih. "TF-Idf - Term Frequency-Inverse Document Frequency." *Learn Data Science - Tutorials, Books, Courses, and More*, www.learndatasci.com/glossary/tf-idf-term-frequency-inverse-document-frequency/#:~:text=Using%20scikit%2Dlearn-,What%20is%20TF%2DIDF%3F,%2C%20relative%20to%20a%20corpus).

"Long Short-Term Memory (LSTM) Networks." *Long Short-Term Memory (LSTM) Networks - MATLAB & Simulink*, www.mathworks.com/discovery/lstm.html#:~:text=LSTMs%20are%20predomina. Accessed 11 Feb. 2024.

M, Remi. "How to Create a Neural Network in Python – with and without Keras." *ActiveState*, 23 Jan. 2024, www.activestate.com/resources/quick-reads/how-to-create-a-neural-network-in-python-with-and-without-keras/.

The Neural Networks Model, 4 Mar. 2021, www.ibm.com/docs/en/spss-modeler/18.0.0?topic=networks-neural-model.

"One Hot Encoding in Machine Learning." *GeeksforGeeks*, GeeksforGeeks, 18 Apr. 2023, www.geeksforgeeks.org/ml-one-hot-encoding-of-datasets-in-python/.

"Sklearn: Feature Extraction with TF-IDF." *GeeksforGeeks*, GeeksforGeeks, 31 July 2022, www.geeksforgeeks.org/sklearn-feature-extraction-with-tf-idf/.

Team, Keras. "Keras Documentation: Layer Weight Regularizers." *Keras*, keras.io/api/layers/regularizers/. Accessed 11 Feb. 2024.

"Vanishing Gradient Problem." Engati, www.engati.com/glossary/vanishing-gradient-problem#:~:text=Vanishing%20gradient%20problem%20is%20a,layers%20to%20the%20earlier%20layers. Accessed 11 Feb. 2024.

Jang, Yeong Jin. "TF-IDF (Term Frequency - Inverse Document Frequency).", 15 May. 2022, https://yeong-jin-data-blog.tistory.com/entry/tf-idf-term-frequency-inverse-document-frequency.

Yu, Won Jun. Ahn, Sang Jun. "02-08 One-Hot Encoding" WikiDocs, 14 Nov. 2022, https://wikidocs.net/22647

Park, Tony. "Vanishing Gradient" Hey Tech, 22 May 2022, https://heytech.tistory.com/388

Jang, Yeong Jin. "LSTM, Bidirectional LSTM." 19 Jan. 2022, yeong-jin-data-blog.tistory.com/entry/lstm

Doe, John. "math - Why use softmax as opposed to standard normalization? - Stack Overflow."

Stack Overflow, 10 years ago, https://stackoverflow.com/questions/17187507
/why-use-softmax-as-opposed-to-standard-normalization

Pure Storage. "CPU vs. GPU for Machine Learning | Pure Storage Blog." Blog.purestorage.com,
22 Sept. 2022, https://blog.purestorage.com/purely-informational/cpu-vs-gpu
-for-machine-learning

"NVIDIA GeForce RTX 4070 Specs | TechPowerUp GPU Database." TechPowerUp, 11 Feb.
2024, https://www.techpowerup.com/gpu-specs/geforce-rtx-4070.c3924.

Duarte, Fabio. "Number of ChatGPT Users (Feb 2024)." Exploding Topics, 2 Feb. 2024,
https://explodingtopics.com/blog/chatgpt-users

Unraveling the Impacts of the 2012 Russian Adoption Ban on Child Rights and Global Dynamics By Grace Burke

ABSTRACT

This research paper investigates the complex relationship between international adoption and its impact as a result of global politics, law, ethics, and international relations. It specifically focuses on the Russian adoption ban implemented in 2012, enacted in response to geopolitical tensions and the Magnitsky Act in the United States. The ban disrupted the adoption processes and raised concerns about adherence to international child rights standards, notably violating Guiding Principle Three of the United Nations Convention on the Rights of the Child (UNCRC). This principle emphasizes prioritizing the "child's best interests" in all decision-making. This examination asserts that the Russian adoption ban severely encroaches on this principle, hindering the child's right to a stable and nurturing family environment. Moreover, the paper explores the ban's historical context, consequences, long-term implications, and recommendations within the UNCRC framework. This paper aims to enhance our understanding of the global adoption landscape's complexities, options, and ethical duties.

1. Introduction

Political tensions, legislative responses, international conflict, and a myriad of global matters have profoundly shaped the international adoption landscape. International adoptions were notably exemplified on the world stage by Russia's comprehensive ban on international adoptions, instituted in December 2012 as a reaction to the passing of the Magnitsky Act in the United States (Human Rights Watch, 2014). The geopolitical climate, diplomatic relations, and governmental policies collectively mold the accessibility and viability of international adoption as a critical aspect, along with legal considerations forming the foundation of international adoption, navigating through diverse legal systems and a labyrinthine of regulations that dictate adoption procedures. This examination exposes the rights, responsibilities, and safeguards governing all parties involved, providing valuable insights into the intricate web that defines international adoption practices. United Nations Convention on the Rights of the Child (UNCRC) Principle 3 underscores the importance and considerations of prioritizing the child's best interests in all actions regarding such decisions involving children.

Prior to the Russian adoption ban in 2012, the adoption landscape from Russia to the United States was marked by significant and commonplace practices, with thousands of Russian children finding homes with American families. The adoption process involved detailed adherence to adoption laws in both the United States and Russia. Prospective adoptive parents in the U.S. underwent comprehensive reviews conducted by licensed social workers assessing suitability, age requirements, and financial stability, among other criteria. However, the adoption relationship between the United States and Russia faced significant obstacles and controversies. Ultimately, in response to the Magnitsky Act, Russia's legislative maneuver banning international adoptions disrupted ongoing adoption processes and raised significant concerns regarding its alignment with international child rights standards. The ban further impacted prospective adoptive families worldwide, with specific harm to the United States. This illustrated a serious deviation

from the UNCRC principles, breaking Guiding Principle Three, which unequivocally prioritizes the child's best interests (UN General Assembly, 1989).

1.1 Statement of Thesis

This research paper argues that the Russian adoption ban egregiously violates the United Nations Convention on the Rights of the Child, notably ignoring Guiding Principle Three, which demands that governments prioritize the best interests of the child. The ban undermines the child's entitlement to a stable and nurturing family environment and a secure, loving, and supportive family abroad when the child's home country cannot provide such an environment. The research delves into the ramifications of Russia's adoption ban within the framework of the UNCRC, examining it through the lens of the foundational tenant, Guiding Principle Three, which places the most importance on the well-being and development of the child as a critical decision-making process involving children (Convention on the Rights of the Child, Article 3).

2. Background

The Magnitsky Act and the subsequent Russian Adoption Ban marked a pivotal turning point in global affairs, human rights, and the welfare of adopted children. The tragic death of Sergei Magnitsky, an auditor who exposed a substantial tax fraud scheme implicating high-ranking Russian officials, prompted the enactment of the Magnitsky Act in 2012. The U.S. Congress aggressively responded by imposing sanctions on involved Russian officials. Russian authorities noted this act as interfering in domestic affairs in a period of heightened US-Russian relations.

As a response to the Magnitsky Act, Russian President Vladimir Putin and the Duma implemented a ban on the adoption of Russian children by U.S. citizens in December 2012. The ban was presented as a protective measure, however, widely considered a politically motivated action. The ban profoundly impacted the adoption landscape, as the United States was previously a significant destination for Russian adoptees, with thousands of successful adoptions recorded annually (UNICEF, 2013). This abrupt cessation disrupted ongoing adoption processes, leaving many children in institutional care or foster systems. Critics contended that employing adopted children as diplomatic pawns was ethically questionable, imposing unjust consequences on innocent children. The broader implications of these events transcended the U.S.-Russia context, shedding light on the ethical responsibilities of nations and the potential vulnerability of adopted children amid diplomatic disputes. The narrative emphasizes the necessity for robust safeguards and ethical considerations in international adoption to uphold the paramount importance of children's well-being. Over the years, this ban has persisted, significantly limiting opportunities for Russian children to find permanent homes abroad, irrespective of the geopolitical climate (Human Rights Watch, 2013).

3. Literature Review

The Russian government's response to the Magnitsky Act and the following enactment of the Dima Yakovlev Law, commonly known as the Russian Adoption Ban, carried profound domestic and international implications, reshaping the future of diplomatic relations. A

comprehensive examination of existing literature on international adoption reveals an environment characterized by growing trends, detailed challenges, and ethical considerations. Earlier studies provide helpful insights into the connection between political decisions and the development of international adoption policies, offering a deeper understanding of the broader dynamics that influenced the implementation of the Russian Adoption Ban.

Exploring the literature on the human rights and ethical implications of the ban, particularly regarding the rights of adopted children, is imperative. Insights from international organizations, non-governmental entities, and scholars contribute to studying the ethical considerations entwined with adopting a political stance through international adoption, highlighting potential vulnerabilities in the system. Investigating comparative works scrutinizing the Russian Adoption Ban alongside analogous adoption bans or restrictions in other countries broadens our perspective. Key findings from the literature stress the impacts of the Russian Adoption Ban by highlighting gaps in research and areas warranting further exploration; this conclusion emphasizes the ongoing need for scholarly scrutiny. The broader implications on international relations, human rights, and the welfare of adopted children remain pivotal, urging sustained scholarly attention to these intricate issues that transcend national borders.

3.1 The UN Convention on The Rights of Child (UNCRC)

Adopted in 1989, UNCRC is a set of comprehensive rights that promote and protect children's rights globally. The rights of each child focus on the needs of civil, political, economic, social, and cultural characteristics, exemplifying these rights' universality, indivisibility, and interdependence (UN General Assembly, 1989). Children's rights are inherent within this international framework, and state parties must ensure their fulfillment without discrimination.

The UNCRC comprises 54 articles delineating specific rights and principles to safeguard children's well-being and development, recognizing the child as an individual with inherent rights, ensuring their well-being and holistic development. The Guiding principles ensure non-discrimination, asserting that every child has equal rights, irrespective of race, ethnicity, gender, religion, or disability. The principle places the best interests of the child at the forefront, guiding governments, institutions, and individuals as the central focus for the children's well-being in all actions and decisions. Acknowledging the right to life, survival, and development, the UNCRC highlights the magnitude of creating conditions conducive to every child's physical, mental, and social growth. Furthermore, the convention advocates for children's active participation in matters affecting them, with due consideration given to their views based on age and maturity. States that are parties to the UNCRC commit to implementing legislative, administrative, and other measures to realize the outlined rights, and the treaty establishes mechanisms for monitoring and reporting on the progress of its implementation.

3.2 Guiding Principle Three

Article 3 of the UNCRC serves as a key player, emphasizing the importance of considering the child's best interests in all actions concerning them (Convention on the Rights of the Child, Article 3). Guiding Principle Three explicitly engages in conversation regarding the child's best interests, asserting that this consideration should be a primary concern in all decision-making

processes concerning children (UNICEF, 2021). This principle recognizes the individuality of each child and the necessity to prioritize their unique needs and well-being. It implies that in matters of adoption, placement, custody, or any other legal or administrative procedures affecting children should be taken into consideration the child's best interests should be given paramount importance (UNICEF, 2021). Key components of the UNCRC Guiding Principle 3 encompass the Holistic Consideration, Individualized Approach, Rights-Based Approach, Participation of the Child, and the Legal and Administrative Measures.

This principle becomes particularly salient in contexts such as adoption, custody disputes, immigration, and any situation where a child's rights and well-being are in question. Nevertheless, applying this principle introduces complexity into decision-making processes and the balancing of conflicting interests while navigating subjective and objective needs. Ensuring the meaningful participation of children in decision-making requires careful consideration of factors like age, maturity, cultural practices, and an understanding of each child's specific needs and circumstances, reinforcing the broader commitment to promoting and safeguarding children's rights globally.

4. Examination of Russian Adoption Ban

Implemented in December 2012, the Russian Adoption Ban was a highly controversial and politically motivated decision that continued to strain US-Russia relations even further after the US enactment of the Magnitsky Act earlier that year. Russia framed the Dima Yakovlev Law (Russian Adoption Ban) as a protective measure against US citizens adopting Russian children. Key provisions of the Dima Yakovlev Law included a ban on US adoptions, Travel Restrictions, Asset Freezing and an Anti-Magnitsky Provision.

The ban had immediate and profound consequences, particularly for ongoing adoptions and adoptive families and left many in emotional turmoil and created a diplomatic rift between the two nations. Critics argued that using adopted children as pawns in a political dispute was ethically questionable, and the ban was seen as an unjust punishment for innocent children based on political motivations. The Russian Adoption Ban underscored the entanglement of international adoption with political maneuvering and raised ethical questions about the responsibilities of nations and the vulnerability of adopted children in diplomatic disputes, extending beyond the U.S.-Russia context, emphasizing ethical safeguards in international adoption to ensure the well-being of children remains a priority.

4.1 Analysis of Reaction and Implications

The Russian Adoption Ban of 2012 elicited a spectrum of reactions, ranging from support within Russia to widespread outrage internationally. In Russia, the ban was met with a degree of public approval, seen by some as a response to the perceived mistreatment of Russian children adopted by U.S. families. The sentiment was fueled by a nationalist narrative, with proponents arguing that the ban protected Russian children from potential abuse and neglect in the United States. Russian officials considered it an infringement on their sovereignty and internal affairs. Dima's case and the ensuing adoption ban triggered widespread condemnation, with critics contending that President Putin's political maneuvers put the well-being of children at risk in

overcrowded and troubled orphanages. Bloggers, notably Yuri Pronko, labeled the law as one of Russia's most shameful moments in history, and social media campaigns, such as "Putin eats children," vividly reflected the public's intense discontent. The ban incited significant protests in Moscow, drawing up to 20,000 demonstrators expressing their disillusionment with the Kremlin. The "March Against Scoundrels" in January 2013 saw demonstrators carrying signs and chanting slogans condemning the ban as a cynical move that disregarded the best interests of the children involved. Protesters carried posters featuring President Putin and parliament members who supported the law, vociferously declaring "shame on the scum."

The opposition argued that the adoption ban unfairly exploited children for political gain, emphasizing the right of adoptive children to loving families. Human Rights Watch and Amnesty International, among other critics, decried the law, warning that it could deprive Russian orphans of the families they desperately needed. Russian Chief Rabbi Berel Lazar underscored that these children should not become pawns in political games. Opponents viewed the adoption ban as retaliation against a new U.S. law targeting Russians accused of human rights abuses. While acknowledging isolated cases of Russian children facing abuse from American adoptive parents, critics argued that such instances were rare. Those opposing the ban accused Putin's government of leveraging anti-American sentiments for political support, stressing the importance of avoiding political maneuvers that put children's lives at stake. Despite attempts to appease public anger by allowing some ongoing adoptions, the controversy highlighted the delicate balance between international relations, domestic politics, and the fundamental rights of adoptive children to a secure and nurturing environment. The ban strained diplomatic relations between Russia and the United States, exacerbating a tense situation.

4.2 Impact of International Adoption

The ban cast a shadow over international adoption practices, drawing attention to the vulnerabilities and risks associated with intercountry adoptions, raising questions regarding the politicization of adoption processes, and using such a vulnerable population as instruments in diplomatic conflicts. This, in turn, influenced public perceptions of international adoption, emphasizing the need for ethical considerations and safeguards.

At the of the time of the ban, over 650,000 children were considered orphans in Russia, with 110,000 living in state institutions, many in need of critical medical care. According to a statistic provided by the Ministry of Science and Education in 2011, there was an urgent need for international adoptions to provide these at-risk children with a chance for a safer physical and emotional life. Among the most heart-wrenching cases were the 46 Russian children who had completed and were approved for adoption by American parents when the ban took effect. These children, who had received court approval and were in the final stages of the adoption process, found themselves stranded in Russian orphanages, their hopes of joining loving families shattered. The ban raised concerns about the fate of many others with severe health conditions, disabilities, and diseases. Statistics reveal that more than half of the affected children had serious diseases, seven were handicapped, four had Down syndrome, and others faced significant health challenges. For example, Mary and her husband were on the cusp of bringing home a 21-month-old boy and now faced the agonizing reality of separation due to the ban's

implementation. Kendra Skaggs, a special-education teacher from Arkansas, documented her 13-month journey to adopt Polina from Russia, only to have her dreams snatched away by the sudden ban. The heartbreak extended to families like Josh and Jenni Johnston, who had formed a bond with 4-year-old Anastasia, and Charles and Elisabeth Smith, who had hoped to welcome 5-year-old Malcolm with cerebral palsy into their home. The ban's consequences extended beyond emotional distress to the critical medical needs of children like Ivan, who suffered from Apert syndrome. Ivan required surgery before the age of five to prevent permanent damage to his brain, but the adoption ban placed a life-saving operation in jeopardy. Similarly, Daria, a child with Down syndrome, died in April 2013 due to an undiagnosed heart ailment, and the ban cut off her adoption. These examples underscore the devastating impact of the adoption ban on the lives of vulnerable children who urgently need medical care and the love of a family.

According to official government statistics, before the Yakovlev law came into force, there were almost twice as many children in orphanages, some 104,000 in 2012 compared to 60,100 by the end of 2015. In 2012, it was reported that Russian families adopted 6,500 children, whereas in 2015, that number was only 5,900. However, international adoption reached an all-time low in 2015 at 746 adoptions compared to 2,400 Russian children adopted in 2012. Anna Kuznetsova, the ombudswomen of the office of Russia's Children, stated that the number of children who were adopted and then later returned to orphanages increased. In 2015, 5,600 children were returned to orphanages from foster families, 6 percent from the previous year. While the official government records noted that the number of children in orphanages dropped from 2012 to 2015, that still left a significant number of children without families as compared to the small handful of children adopted each year by Russian families.

4.3 Analysis through the Violations of Guiding Principle Three

The Russian Adoption Ban raises serious concerns given its notable violations of the UNCRC Principle 3, mandating children's overall welfare as the topmost priority, including aspects of physical, mental, emotional, and social well-being as well as their long-term impacts. The ban initiated an abrupt halt to international adoption of Russian children with specific antagonism toward US citizens. The immediate interruption of all internal adoptions of Russian children illustrated a complete disregard for the children involved, violating the central tenets of the principle, all while jeopardizing international relations and creating a sense of uncertainty and emotional distress for all parties involved.

According to the primary guidelines, Principle 3 directly states that "Parties undertake to ensure the child such protection and care as is necessary for his or her well-being, taking into account the rights and duties of his or her parents, legal guardians, or other individuals legally responsible for him or her, and, to this end, shall take all appropriate legislative and administrative measures.", which was unequivocally violated by Russia when the international adoption ban was put into law. This principle underpins the importance of considering the child's best interests in all actions concerning them (Committee on the Rights of the Child, 2014). Russia utilized a one-size-fits-all strategy in issuing a blanket prohibition of international adoptions, with specific prohibits affecting only US citizens, neglecting the affected children's individual and family circumstances.

Furthermore, the principle highlights the child's participation in decision-making according to age and maturity. Unfortunately, in the case of the Russian Adoption Ban, affected children were not permitted to express their views on the matter. The decision was made at a political level without considering their perspectives, indicating a potential disregard for the principle's emphasis on the active involvement of children in decisions that profoundly impact their lives.

5. Framework of International Adoptions

The international adoption framework involves a combination of legal processes, international conventions, national regulations, governance, and international cooperation to ensure children's safe and equitable adoption abroad. International adoption poses specific solutions for child welfare considerations as it addresses critical issues of stable home environments and access to medical and health facilities. It also assists countries in finding nurturing homes for orphaned or abandoned children in need of routine care not available in their home countries. From the perspective of globalization, international adoption engages cultural diversity, fosters global unity and understanding, and forms solid international bonds with the home and adoptive countries. Studies indicate that children raised in such diverse families gain exposure to various cultures, nurturing values of tolerance and empathy, and an enriched appreciation for diversity.

5.1 Importance of International Adoption

Serving an opportunity for these vulnerable children, international adoption not only provides tangible opportunities for a better life, education, and emotional support but also plays a crucial role in fostering cross-cultural understanding, acting as a catalyst for global unity. International adoption strategically addresses the strain on local adoption systems, especially in regions burdened with high rates of orphaned or abandoned children. By enabling children to find families beyond their borders, this practice helps rectify the imbalance between the demand for adoption opportunities and the available resources within a given country, thereby contributing to a more equitable distribution of adoption opportunities globally. The result of international adoption expands beyond relocation, encompassing the holistic well-being and development of the adopted children. It provides the children with the essential components for growth, including proper education, healthcare, and emotional support, thereby creating a positive ripple effect that contributes to the global community by fostering a generation with the opportunity to realize its full potential.

5.2 Case Study Analysis

A plethora of well-documented cases greatly illustrate the positive outcomes witnessed when children are placed in nurturing families abroad, revealing significant enhancements in their physical and emotional well-being, educational accomplishments, and enduring stability. A few successful Russian adoption stories follow below.

Many, like 21-year-old Alexander D'Jamoos, have written letters and petitions to President Putin as well as initiated an online petition which had been delivered to the Russian Embassy in Washington, D.C. to assist in changing the current policy against Russian adoptions. D'Jamoos

was adopted from Russia when he was 15 years old after living his entire life in an orphanage with a disability that prevented him from walking. Alexander D'Jamoos, a Russian adoptee, shared his own story about being abandoned by his parents due to his disabilities, living in a Russian orphanage in Nizhniy Lomov, and finally being adopted at the age of fifteen. According to D'Jamoos, "[i]f there's an opportunity for a family, I think it's immoral to take it away from a child.". Since his adoption, D'Jamoos has undergone surgery to amputate his legs allowing him to wear prosthetics, which helped him achieve a life goal of climbing Mount Kilimanjaro. These success stories affirm the indispensable role of international adoption in ensuring children's rights to a nurturing and supportive environment.

5.3 Consequences of the Ban

One significant consequence is the reduced placement opportunities for children, resulting in a very uncertain future. Prolonged institutionalization becomes a pressing concern, directly contradicting the UNCRC's commitment to ensuring the child's right to family and, if possible, adoption. Older children and sibling groups face heightened challenges, as the ban limits their chances of finding permanent homes, undermining the principles of the UNCRC. However, children with special needs or in need of intensive medical care face the most significant challenges, bearing the brunt of restricted international adoption options. The ban's impact on resource allocation further hinders providing support services to families, infringing the UNCRC's focus on the child's right to social and medical care and extending the adverse effects through to increased stigma and discrimination, directly conflicting with the mandate to protect children from all forms of discrimination. The limitations on international adoption also result in the loss of opportunities for childless families.

6. National and International Conflicts on the Adoption Process

The breakdown of family structures is a poignant consequence of conflict, where the loss of parents, displacement, and economic hardships render children vulnerable and bereft of familial support. The heightened vulnerability of children during conflicts encompasses risks of abuse, exploitation, and recruitment into the armed forces, compelling adoption as a protective measure to extricate them from these dangerous environments. The strain inflicted on local care systems by national crises amplifies the difficulty for governments to offer adequate support and protection for orphaned or vulnerable children, positioning adoption—whether domestic or international—as a mechanism to alleviate this burden.

The aftermath of adoption in conflict contexts necessitates robust post-adoption support. Children who have undergone trauma require specialized care, and families need resources to navigate the unique challenges associated with adopting children from crisis-affected regions. International cooperation becomes indispensable in this landscape, demanding collaboration between nations, NGOs, and international bodies to uphold the child's best interests and ensure that adoption processes adhere to ethical standards.

6.1 Impact of National and International Conflict on Child Welfare

The ramifications of national and international conflicts stemming from political upheavals and economic instability introduce formidable challenges within the country's social and economic systems, particularly impacting vulnerable demographics, such as children. Due to more immediate concerns, the reallocation of resources away from vital social welfare programs, encompassing support for orphanages and institutional care, precipitates a shortage of funding and support for institutions responsible for vulnerable children. The turbulent environment engendered by political tensions resonates through foster care systems as families wrestle with economic strain and uncertainty, lowering their ability to foster children. This, in turn, causes severe psychosocial tolls on children, resulting in displacement, violence, and trauma as recurrent outcomes of political conflicts. Vulnerable children find themselves at an elevated risk of exploitation, such as human trafficking or forced labor, as social systems disintegrate, rendering the enforcement of laws and protection challenging. Furthermore, heightened restrictions on NGOs and civil society groups curtail essential support for these children, impeding resources and assistance. Additionally, political unrest obstructs administrative processes like birth registration, leaving unregistered children exposed and grappling with accessing indispensable services, thereby imperiling their lives and stability, as emphasized in Section 3 of the UNCRC.

The strain on social services is a consequential fallout of national conflict, placing immense pressure on government agencies and manifests as a challenge in providing the requisite support and protection for children, creating gaps in essential services that directly impact child welfare. Educational systems also bear the brunt of conflict, leading to school closures, displacement of teachers, and disruptions in the learning process, with potential long-term consequences for children's academic and personal development. Healthcare challenges emerge prominently during the conflict, with limited access and consistent obstacles to timely medical attention, vaccinations, and necessary healthcare services for children. The psychosocial effects of conflict are profound, subjecting children to trauma and stress due to exposure to violence and instability, with enduring implications for their mental health and emotional well-being. International conflicts and geopolitical tensions introduce complexities into adoption policies, affecting diplomatic relations and adoption procedures. The role of humanitarian organizations becomes paramount, stepping in to provide aid, protection, and support to children affected by conflict. Cultural considerations take center stage in efforts to preserve children's cultural identity, emphasizing the importance of interventions, including adoption, that respect and maintain connections to their cultural heritage. The long-term consequences of conflict on child welfare are inter-generational, perpetuating cycles of vulnerability, emphasizing the need for comprehensive strategies.

6.2 Establishment of Stable Environments

UNCRC Article 7 takes center stage, emphasizing a child's right to name, identity, and family relations—rights significantly disrupted by displacement. In Russia, internal displacement in conflict-affected regions exerts pressure on local resources, directly impacting the stability and rights of children within these areas. As many of these individuals and families are displaced, fundamental family structures are disrupted due to conflict-induced parental loss or separation. UNCRC Articles 5 and 9, championing the right to parental guidance and maintaining family unity, confront jeopardy. Families in conflict-affected areas of Russia grapple with preserving

their structures, consequently impacting the emotional well-being and overall stability of the children entangled in these circumstances. Overcrowded living spaces, inadequate facilities, and insufficient resources in orphanages directly compromise the right to a suitable standard of living for children. Housing instability and inadequate living conditions foster family separations, placing children in institutions and jeopardizing their right to family stability. Limited access to rehabilitation services and support for substance abuse exacerbates family instability, leading to neglect and further infringement upon the child's rights. Children contending with violence, displacement, and trauma during conflict encounter profound psychosocial challenges. The alignment of UNCRC Article 3, emphasizing the best interests of the child, with Article 39, focusing on recovery and reintegration post-violence, becomes crucial. In conflict zones within Russia, children endure psychological consequences, necessitating specialized support and interventions to address their unique needs.

Along with a disruption in education and limited means of healthcare, conflict amplifies vulnerability to exploitation, including human trafficking and forced labor. UNCRC Articles 32 and 38, focusing on protection from economic exploitation and involvement in armed conflicts, gain prominence. Protective measures become indispensable in conflict zones within Russia to safeguard children's rights and overall well-being. Administrative processes, notably birth registration, encounter barriers during conflict. Moreover, national crises result in backlogs in adoption and foster care vetting processes, delaying children's placement in stable homes, and compromising their right to a timely and supportive family environment. Reduced oversight during crises underscores the urgent need to address these challenges to uphold the safety and well-being of children, with limitations on international adoption further complicating these issues and violating the UNCRC's commitment to protecting every child's rights.

6.3 Comparative Adoption Policy Analysis
Comparative analyses shed light on successful practices safeguarding children's rights in crisis-stricken regions (Red Cross, 2021). Clear legal frameworks, compliance with conventions like the Hague Adoption Convention, and cultural sensitivity emphasize preserving the child's heritage. Efficient administrative processes, streamlined procedures, thorough evaluations of prospective adoptive parents, and monitoring mechanisms contribute to timely and stable placements. Countries like Sweden, Norway, Finland, Canada, the Netherlands, the United States, Australia, the United Kingdom, and New Zealand exemplify these best practices, emphasizing ethical adoption, child welfare, cultural sensitivity, and comprehensive support services. These practices collectively contribute to a child-centric international adoption system prioritizing the well-being and rights of adopted children.
Analyzing adoption policies in nations confronting parallel national conflicts to Russia offers valuable insights into various approaches to navigating the intricate intersection of adoption and conflict. While each country's policies exhibit distinctiveness, a thorough examination of commonalities and distinctions can illuminate best practices and potential areas for improvement. Below are a few examples of adoption policies of nations contending with comparable challenges:

1. *Syria:* Syria has faced prolonged conflict, resulting in a significant refugee crisis and internal displacement. The Syrian government has implemented measures to protect

children affected by the conflict. International adoptions are subject to strict regulations, prioritizing local adoption options whenever possible. The focus is on maintaining cultural and familial ties for the child's well-being.

2.   _Iraq:_ Iraq has experienced political instability and conflict, leading to internal displacement and humanitarian challenges. Iraq's adoption policies aim to balance the needs of vulnerable children with cultural considerations. Efforts made to prioritize domestic adoption and international adoption are subject to thorough screening and approval processes. The emphasis is on providing a stable environment while respecting the child's cultural background.

3.   _Ukraine:_ Ukraine has faced geopolitical tensions and internal strife, impacting social systems and vulnerable populations. Ukraine's adoption policies focus on protecting the rights and well-being of children. International adoption is regulated to ensure transparency and ethical practices. The government works to strengthen domestic adoption services, reflecting a commitment to providing stable environments for children within the country.

Common themes emerge in comparing these adoption policies, such as prioritizing local adoption, safeguarding children's rights, and maintaining cultural connections. Understanding these diverse approaches can contribute to developing nuanced and context-specific adoption policies in the face of national conflict.

7. Legal and Ethical Considerations

     The Russian adoption ban has numerous legal concerns, particularly its impact on international adoption laws and the fundamental rights of children. International adoption is governed by national domestic laws, bilateral agreements, and international treaties, including the UNCRC, of which the Russian Federation is a signatory. Legal experts from Sanatsia Prava assert that the adoption ban was enacted "with numerous procedural irregularities," contradicting the Russian Constitution and the Russian Family Code, violating the UNCRC. The breach of both international treaties and domestic laws accentuates the illegality of the Russian adoption ban and its direct conflict with the UNCRC's commitment to ensuring the child's best interests in all actions concerning them, extending beyond national boundaries, raising broader questions about adherence to international norms in safeguarding children's rights within the realm of adoption.

7.1 International Law and Adoption Rights

     International law plays a crucial role in shaping and safeguarding adoption rights globally. The principles and frameworks established by international agreements and conventions provide a foundation for ethical, legal, and human rights considerations in the adoption process. Key Rights and Principles applicable to children, including those related to adoption consist of the UNCRC and Adoption Rights, the Hague Adoption Convention, the Best Interests Principle, National Legislation and Implementation, Ethical Considerations, and Ongoing Challenges and Evolving Standards. International law, specifically through instruments like the UNCRC and the Hague Adoption Convention, establishes a framework for adoption rights that prioritizes the child's best

interests and seeks to prevent abuses within the adoption process. National legislation, ethical considerations, and ongoing efforts to address challenges contribute to the evolution of international standards in adoption rights.

7.2 Ethical Considerations of Banning International Adoption

The ban has sparked ethical debates, bringing to the forefront the ethical and moral responsibilities of nations in upholding children's rights as the primary consideration. The conversation on the implications of political maneuvering and decision-making plays an important role in understanding the direct impact to vulnerable populations.

Opponents: Critics vehemently oppose the adoption ban, criticizing what they perceive as the subordination of political interests to the well-being and rights of children. Detractors argue that subjecting these children to prolonged stays in institutions, an outcome of reduced international adoption opportunities, is fundamentally unethical as it compromises their overall well-being and developmental prospects. A pivotal argument against the ban centers on violating children's rights, asserting the ethical imperative of affording children the chance for a stable and loving family life, irrespective of political tensions between countries. Opponents underscore the ban's consequences for adoption options, particularly for vulnerable groups such as children with special needs or those in sibling groups, limiting their chances of finding adoptive families. Observers note the deployment of adoption as a political tool, evident in its timing concerning the Magnitsky Act, raising ethical questions about the ban's motives. Critics argue that leaving thousands of children in Russian orphanages as a result of the ban underscores the ethical irresponsibility of nations in prioritizing political alliances and fortitude over the best interests of children. The ban has a detrimental impact on the psychological well-being of institutionalized children, especially those with disabilities, shedding light on the deficiencies within the Russian orphanage system and the potential harm inflicted on these vulnerable children. Supporters assert that the adoption ban, while controversial, protects national interests, prevents potential child abuse and neglect, promotes domestic adoption, cultural cohesion, and addresses corruption concerns within the international adoption system.

Supporters: Central to this endorsement was the assertion of national sovereignty, with advocates contending that the ban is essential for preserving Russia's autonomy and reclaiming authority over its adoption processes. This stance emphasizes the necessity of regulating international adoption to prevent potential abuses and safeguard the rights of adopted children within the country. Supporters of the adoption ban voiced concerns about transparency and ethical practices within certain international adoption agencies, alleging involvement in unethical practices such as child trafficking and exploitation. From their perspective, the ban served as a means to address these concerns and shield Russian children from potential abuses, particularly those involving neglect and abuse within foreign adoptive families. Corruption concerns within the international adoption system constitute another rationale for the ban. Officials express apprehensions about fees, donations, and profit-driven practices associated with foreign adoptions. The emblematic case of Dima Yakovlev is frequently cited, symbolizing not only potential child abuse but also deeply rooted corruption within the adoption process. Nationalist rhetoric played a pivotal role in these arguments, exemplified by President Vladimir Putin's statement: "There are probably many

places in the world where living standards are better than ours. So what? Shall we send all the children there or move there ourselves?" This sentiment underscores the belief that keeping Russian children in their home country is both a point of national pride and a protective measure against potential abuses in foreign nations. It accentuates the significance of prioritizing domestic adoption within Russia, with resources directed toward strengthening the national adoption system to ensure that families within the country can adopt Russian children. Supporters of the ban stressed the importance of encouraging domestic adoption within Russia, contending that by restricting international adoptions, more families within the country would be motivated to adopt, thus addressing the needs of orphaned and abandoned children domestically. Some lawmakers endorsed the adoption ban within the State Duma, Russia's lower house of parliament, echoing the sentiment that it was in the best interest of Russian children, arguing for the need to assert control over international adoption processes. Advocates emphasized the importance of finding national solutions to address the welfare of orphaned and vulnerable children, believing that relying on domestic resources and initiatives would better serve the needs of Russian children.

7.3 Shortcomings of the Legislation

Although supporters of the ban bring up multiple reasonable concerns regarding international adoption, the Russian adoption ban does not sufficiently address these problems; the 2012 Russian adoption ban encountered substantial criticisms and several noteworthy legislative shortcomings across different dimensions. Foremost among these was the adverse impact on the well-being of Russian children either in the process of adoption by foreign families or eligible for international adoption. Critics claimed that the ban resulted in prolonged stays in institutions, significantly affecting these children's overall development and prospects. UNICEF estimates there are about 740,000 children not in parental custody in Russia, while about 18,000 Russians are on the waiting list to adopt a child. In 2011, nearly 120,000 children in Russia were eligible for adoption. Approximately 7,400 were adopted by Russian families, and 3,400 adopted by families abroad. Since the law banning American adoptions was passed, Russian political and religious leaders have been encouraging Russians to adopt more children. Furthermore, the restriction of adoption options for specific groups, including those with special needs, older children, and siblings, was viewed as detrimental, limiting their chances of securing suitable adoptive families, noting that approximately 3000 children per year would be unable to reap the benefits of placement in a family environment. Additionally, ill, and disabled children would be most severely disadvantaged by the adoption ban because they receive lower-quality care in Russian institutions and are less likely to be adopted by Russian families.

While there have been cases of abuse and neglect of children adopted from Russia in the United States, proponents ignored the fact that children face potential abuse in the Russian Federation as well. Data illustrates that over the past twenty years, only 19 out of 60,000 Russian children adopted by families in the United States have died at the hands of their adoptive parents, while 1,200 adopted children died because of abuse in Russian households, according to the Moscow Children's Rights Ombudsman over the same time period. However, this information should be re-evaluated when more comparative data is available to ensure accurate findings. Humanitarian concerns were amplified by the perception that Russia deployed adoption as a political tool,

particularly in response to diplomatic tensions. The timing of the ban concerning the Magnitsky Act fueled accusations of political leveraging at the expense of vulnerable children, raising significant ethical questions. Diplomatically, the ban strained relations, especially with the United States, disrupting collaborative efforts between Russian and foreign adoption agencies and impeding progress in adoption practices and child welfare.

The ban's failure to address inadequacies within Russia's domestic adoption system, including malnourishment, psychological neglect, and limited opportunities for disabled children within orphanages, was a glaring shortcoming. This lack of attention to systemic issues highlighted a missed opportunity to comprehensively reform and improve the domestic adoption and child welfare systems in Russia. Critics underscored the absence of alternative solutions, emphasizing the need to explore nuanced approaches that would address concerns about the well-being of Russian children, while encompassing its impact, diplomatic ramifications, ethical considerations, deficiencies in the domestic adoption system, human rights violations, and the absence of viable alternatives.

8. Discussions

8.1 Human Rights: Corruption

The history of international adoption is marred by corruption, a persistent issue that has cast a shadow over the welfare of adopted children. Like many other countries, Russia has been entangled in this web of corruption within the adoption system. The implementation of the adoption ban, while aimed at curbing corruption involving American adoptive families, fails to address the systemic issues deeply rooted in Russian orphanages. Rather than eradicating corruption, the ban redirects the focus, allowing people from other countries to continue adopting children from Russia, perpetuating the same corrupt practices. Corruption in Russian adoption often stems from bureaucratic inefficiencies and bribery within the highly bureaucratic system. While the ban may reduce corrupt activities related to American adoptive families, it does not provide a comprehensive solution to broader corruption within the Russian adoption system. The historical context of international adoptions reveals instances of exploitation and abuse, such as during conflicts like the Balkans conflict and the collapse of communism in Romania, leading to child trafficking and coercion. The profit-driven adoption trade has raised ethical questions about the motivations behind international adoptions. Proposals for effective solutions involve aggressive screenings of orphanage administrators during the adoption process to address corruption at its roots. Additional solutions include regular audits of adoption agencies and orphanages with specific emphasis on financial transactions and asset holding.

The alleged involvement of some international adoption agencies in unethical practices, including child trafficking and exploitation, led to the ban to curb these practices and protect Russian children from potential abuses post-adoption. Proponents argue that restricting international adoptions, especially in countries with questionable ethical practices, reduces the potential for corruption and exploitation. However, the ban faced criticism for exacerbating issues rather than solving them, preventing children from finding adoptive families, and not adequately addressing the root causes of corruption in the Russian adoption system. Addressing corruption is crucial for safeguarding the rights and well-being of adopted children, but finding balanced and

practical solutions that do not hinder the possibility of children finding loving homes is equally important. While corruption is a genuine concern, the ban's unilateral approach fails to address the issue comprehensively and perpetuates geopolitical tensions. The historical context of the adoption of trade highlights the need for systemic reforms.

8.2 Human Rights: Children's Rights

The adoption ban directly encroaches upon fundamental human rights recognized under international human rights law. The right to family life, a cornerstone articulated in various human rights conventions, is compromised by limiting opportunities for children to access stable and supportive families through international adoption. This infringement contradicts principles outlined in these conventions, undermining the fundamental rights of children to grow up in a nurturing and stable environment (UN Human Rights Council, 2015). Human Rights Watch asserts that the United Nations and the Council of Europe should assess the law's compliance with international and regional human rights norms. According to Jo Becker, the director of the children's rights division at the Human Rights Watch, the adoption ban harms Russia's orphans by diminishing their chances of being adopted, deeming it wrong to make vulnerable children pawns in a cynical act of political retribution. Article 8 of the UNCRC underscores the child's right to preserve their identity, including family relations. By restricting international adoptions, the ban focuses on domestic adoption within Russia. Proponents assert alignment with the right to a family environment, but critics contend that systemic issues within Russian orphanages, such as malnourishment and psychological neglect, remain unaddressed. The ban's impact on the domestic adoption system is crucial in evaluating its compliance with this fundamental right. Considering protection from exploitation and abuse (Article 19) within the UNCRC, particularly in the context of corruption concerns associated with international adoption, critics argue that the ban may not comprehensively address corruption within the Russian adoption system. The ban's unintended consequence of limiting adoption options might expose children to prolonged institutional stays, potentially impacting their well-being.

Amid criticisms at the time, Russia's deputy prime minister and other officials urged President Putin not to sign the law due to violations of international treaties, including the Convention on the Rights of the Child. Human Rights Watch called for an assessment by the UN Committee on the Rights of the Child, emphasizing the Convention's commitment to the child's best interests. Legal experts and human rights advocates raised concerns about potential violations resulting from the adoption ban, emphasizing the need for alternative solutions. The Council of Europe was urged to call on its Venice Commission to examine the law's compatibility with the European Convention on Human Rights.

8.3 Advocacy and Political Implications

Addressing Russia's adoption ban requires strategic approaches aimed at policy reconsideration and advocacy for children's rights. International organizations, NGOs, and diplomatic efforts play pivotal roles in engaging with Russian authorities, highlighting the ban's adverse effects on children, and endorsing its reversal (Human Rights Watch, 2019). *Strategies in Addressing Russia's Adoption Ban:*

1. *Diplomatic Engagement:* Initiating collaborative dialogues with Russian policymakers can be a pivotal channel to underscore the importance of upholding children's rights to stable family environments.

2. *Legal Advocacy:* Strategically partnering with international human rights organizations becomes essential to fervently advocate for the rights of children affected by the ban. In tandem, exploring legal avenues to challenge the ban's compliance with international treaties and conventions is crucial. Engaging legal experts and human rights lawyers comprehensively assesses the ban's legitimacy under international law.

3. *Humanitarian Aid and Support:* Providing substantive humanitarian aid and support to Russian orphanages is a tangible step to enhance the living conditions for children unable to pursue international adoption. Prioritizing the implementation and support of child welfare programs, focusing on education, healthcare, and psychosocial support, becomes paramount for fostering developmental progress within Russia.

4. *Public Awareness and Advocacy:* This involves leveraging media campaigns, documentaries, and social media platforms to spotlight the narratives of affected children and advocate for a reconsideration of the ban. Simultaneously, mobilizing civil society organizations both within Russia and internationally becomes instrumental.

5. *International Collaboration:* Strategic collaboration with international and Russian NGOs dedicated to child welfare, adoption, and human rights is imperative.

Advocacy for international adoption that prioritizes transparent and ethical processes is crucial to safeguard the child's best interests. Further, creating specific strategies to prevent unnecessary institutionalization involves supporting initiatives promoting family-based care options like kinship or foster care.

Role of the UN in Resolving International Adoption Conflicts:

As the principal international body championing children's rights, the United Nations (UN) plays a fundamental role in addressing and resolving international adoption conflicts. By providing a framework for cooperation, establishing global standards, and promoting the rights and well-being of children, the UN wields influence enabling the UN to pressure member states, including Russia, to reevaluate and amend policies hindering children's rights to family life and adoption (UNICEF, 2020). The UN can leverage collaborative efforts and diplomatic channels to advocate for the reversal of adoption bans and promote alternative solutions that benefit the affected children. In collaborating with specialized agencies like UNICEF, the UN can provide guidance and oversight on global adoption issues, engaging with Russian authorities to emphasize children's rights and international adoption standards.

The UN Human Rights Council can issue resolutions condemning adoption bans as violations of children's rights, urging countries like Russia to reconsider. Collaborating with NGOs focused on children's rights and adoption rights raises awareness about the negative impacts of adoption bans and garner public support. Experts like the UN Special Rapporteur on the sale of children, child prostitution, and child pornography can delve into the effects of adoption bans. The UN supports capacity building in countries to strengthen their domestic adoption systems, contributing to preventing and resolving conflicts. In conflicts, the UN can play a role in dispute resolution and mediation through diplomatic channels and international forums.

As an enforcement mechanism, publicly naming offenders could be potent. Publicizing the challenges faced by orphans, particularly those twice abandoned, and highlighting the difficulties resulting from adoption bans could draw attention to negative consequences.

Awareness and Mobilization for Policy Change:

A strategic and comprehensive approach is essential to reverse the Russian adoption ban to raise public awareness and garner widespread support for policy change. By leveraging diverse platforms, partnering with influencers, collaborating with advocacy groups, and launching online petition campaigns, advocates can construct a compelling case for reevaluation, emphasizing the crucial need to prioritize the welfare of vulnerable children. Initiating public campaigns, working with the media, and mobilizing grassroots movements can amplify the voices advocating for the well-being of children affected by the ban (Smith, 2018). Digital outreach not only establishes a broad and easily accessible channel for involving the public but also facilitates immediate updates and interactions, nurturing a community spirit among supporters. Teaming up with NGOs and advocacy groups devoted to adoption and child welfare amplifies the influence of advocacy efforts. Participating in ongoing campaigns and initiatives enables individuals and communities to enhance their collective impact, leveraging the expertise and resources of established organizations.

8.4 Alternative Solutions to the Adoption Ban

Promotion of Domestic Adoption Programs:

One alternative solution to the Russian adoption ban involves strengthening domestic adoption programs within Russia. Improving and supporting domestic adoption initiatives could offer more opportunities for Russian children to find permanent homes within the country. Investing in resources, awareness campaigns, and support systems that encourage domestic adoption is vital as it reduces the dependency on international means. Components of this strategy focus on streamlining adoption processes, addressing the unique needs of children without parental care, and cultivating a culture that promotes domestic adoptions. Engaging with nationwide public awareness campaigns and educational programs for prospective families, developing a positive attitude towards adoption, and reinforcing support services such as counseling and parental classes will dispel negative connotations towards adoptions and likely change the mindset of families. Additionally, by providing financial incentives, Russia can alleviate any financial burdens or considerations hampering the adoption of children. Initiatives like mentoring programs, media collaborations featuring positive adoption stories, and government recognition of adoption achievements create a supportive environment for adoption within Russia. These combined efforts align with UNCRC Article 3, ultimately benefiting the well-being of orphaned and abandoned children.

Putin signed an executive order to improve approval for domestic adoptions and foster care arrangements, simplify adoption procedures, and change attitudes in Russia about adoption. "The executive order improving conditions for Russia's orphans is laudable, but no substitute for using all options to ensure they grow up in a family environment," Becker said. Streamlining, efficiency, transparency, and accessibility for prospective adoptive parents should be prioritized. Integrating technology solutions to reduce paperwork and bureaucracy can further facilitate adoption

processes. Additionally, providing financial incentives to such stakeholders through tax exemptions, deductions, subsidies, and exceptional support services assistance can increase overall capabilities and make adoption services more financially feasible. Improving foster care programs by providing training and resources for foster parents is essential to enhance their capacity to care for children with diverse needs.

Encouraging Transnational Foster Care Programs:

Designing transnational foster care programs could be another viable alternative to the ban. These programs facilitate temporary placements of children in foster families across borders, providing children with stable and nurturing environments while efforts continue to secure permanent placements (Smith, 2020). Promoting transnational foster care programs in Russia represents an innovative approach to addressing the needs of vulnerable children. This initiative can provide unique opportunities for children needing help finding suitable placements within their home country by encouraging collaboration between Russia and other countries, particularly those with established foster care systems. Engaging in diplomatic dialogues and forming agreements between nations can create a foundation for executing such programs. This involves developing guidelines and training programs that educate foster families about the cultural background, traditions, and language of the children they may host. Simultaneously, collaboration with international organizations specializing in child welfare and fostering can offer expertise and support in navigating cross-cultural challenges. Transnational foster care programs are paramount. Establishing agreements between countries participating in transnational foster care programs is essential to safeguard children's rights and the well-being of foster families. Clear guidelines outlining the responsibilities and rights of both sending and receiving countries and foster parents must be established. Financial support for sending countries is vital for developing and sustaining effective transnational foster care programs.

Establishing Special Guardianship Arrangements:

Introducing Special Guardianship Arrangements (SGAs) in Russia can serve as a valuable mechanism for providing stable and supportive family environments for vulnerable children. SGAs involve appointing a guardian who assumes long-term responsibility for a child's welfare, offering an alternative to traditional adoption. These arrangements, designed to ensure the child's welfare and stability, allow for legal guardianship without severing all ties with the child's birth family, enabling children to experience familial bonds despite adoption restrictions (UNICEF, 2019). Rigorous screening processes, encompassing thorough background checks and psychological evaluations, are indispensable for selecting guardians capable of fostering a nurturing environment. Support services and comprehensive training covering child development, trauma-informed care, and cultural sensitivity are essential for prospective special guardians. Furthermore, ensuring cultural inclusivity, instituting rigorous monitoring practices, providing financial support, fostering public awareness, securing legal recognition, and engaging in collaborative efforts with NGOs and international organizations collectively enhance the effectiveness of SGAs in Russia.

8.5 Long-Term Impacts

The ongoing impact of the Russian adoption ban on children's well-being remains a concerning issue. Prolonged institutionalization or lack of stable family environments can significantly impede children's emotional, psychological, and social development (UNICEF, 2021). Studies suggest that extended stays in institutional care settings can lead to developmental delays, attachment issues, and difficulties in forming healthy relationships, underscoring the critical need for timely interventions to safeguard children's rights to family life. Comparable to orphans in other nations, those in Russia may endure long-term adverse effects rooted in early life experiences and institutionalization. Such effects encompass attachment issues, psychosocial challenges, behavioral problems, cognitive delays, emotional regulation difficulties, limited life skills, higher risks of substance abuse and homelessness, social isolation, and continued societal stigma. Adoption addresses diverse long-term adverse effects and provides the stability and nurturing environments essential for the well-being and development of orphans.

9. Recommendations

Policy reform becomes imperative to protect children's rights in light of the ban's adverse effects. Collaboration between national and international stakeholders is essential to initiate policy amendments. Policymakers should consider revisiting and revising adoption regulations, ensuring compliance with international child rights standards while addressing geopolitical concerns (Human Rights Watch, 2020). The integration of child-centric policies that prioritize the child's best interests in adoption decisions should be at the forefront of these reforms.

Addressing the Russian ban on international adoption requires a nuanced approach involving diplomatic, policy, and collaborative efforts. Diplomatic engagement is crucial, establishing open communication channels between affected countries and Russia, fostering dialogue, and building trust. Negotiating bilateral agreements is another critical strategy, ensuring clear and transparent guidelines for international adoption processes and prioritizing the child's best interests and ethical practices. The establishment of joint oversight committees with representatives from both Russia and adopting countries can monitor and ensure compliance with agreed-upon standards. Participation in international adoption reform initiatives, collaboration with organizations like UNICEF, and promoting domestic adoption within Russia are essential components. Strengthening the child welfare system, engaging in human rights advocacy, fostering educational exchange programs, promoting transparency in adoption processes, and supporting humanitarian initiatives are all vital measures. Encouraging collaborative research on adoption practices and sharing data between countries can inform evidence-based policies and contribute to the well-being of adopted children.

Crisis intervention and support programs should be established to address the immediate and long-term needs of children affected by adoption bans, particularly those experiencing prolonged institutionalization. Standardized data-sharing protocols can facilitate the exchange of vital information related to child welfare and adoption processes. Policies supporting guardianship and kinship care as alternatives to formal adoption should be enhanced, accompanied by comprehensive post-adoption services for internationally adopted families. Cross-border collaborations on child protection initiatives, regular reviews of adoption policies, and legal advocacy for adoptive families are essential. Family preservation programs addressing the root

causes of child abandonment, legal protections for adoptive families, and positive public diplomacy campaigns promoting international adoption are vital components. The commitment of advocacy groups, NGOs, and international bodies is crucial in persistently pushing for policy changes, monitoring the well-being of affected children, and providing essential support services (Smith, 2021). Notable organizations championing the need for advocacy in international adoptions include UNICEF, a global advocate for children's rights influencing policies, legislation, and social attitudes to ensure the well-being and protection of children, and the National Council for Adoption (NCFA), which actively supports children's rights and ethical international adoption, among other institutions.

10. Conclusion

The Russian adoption ban, originating from geopolitical tensions, starkly contradicts the principles enshrined within the UNCRC. This ban disrupts international adoption processes and infringes upon children's fundamental rights, notably the right to a family environment, as articulated in UNCRC Article 3 (UN General Assembly, 1989). Our exploration has consistently underscored its violation of international child rights standards, notably the UNCRC's Guiding Principle Three, emphasizing the importance of considering the child's best interests (Committee on the Rights of the Child, 2014). Numerous implications stemming from the ban have come to light throughout this examination. It disrupts children's access to stable environments and carries the potential to influence global adoption policies (UNICEF, 2020). Despite these challenges, identified alternatives such as strengthening domestic adoption programs, fostering transnational foster care initiatives, and advocating for policy reforms based on children's best interests offer viable pathways forward (Smith, 2020).

The global implications of this ban underscore the necessity for international collaboration and an unwavering commitment to children's rights. The global community must prioritize the rights of every child, transcending geopolitical tensions. A robust call to action emerges, urging sustained advocacy, collaborative initiatives, and steadfast commitment to policy reforms prioritizing children's best interests (Human Rights Watch, 2021). With its influence and platforms, the United Nations holds the responsibility to intervene, advocating for policy changes that safeguard children's rights to stable and nurturing family environments.

Works Cited

3 News. (n.d.). Russians march against US adoption ban. Copyright 2009 TV3.
https://web.archive.org/web/20130311094027/http://www.3news.co.nz/Russians-march-against-US-adoption-ban/tabid/417/articleID/282914/Default.aspx

Andrew Horansky / KHOU 11 News. (n.d.). Houston families devastated by adoption ban.
khou.com.
https://web.archive.org/web/20130101080422/http://www.khou.com/news/local/Houston-families-devastated-by-adoption-ban-185089311.html

As conflict changes, so do the dangers for children. (n.d.). UNICEF.
https://www.unicef.org/blog/conflict-changes-so-do-dangers-children

Bigg, C. (2015, December 23). 10 laws Putin's foes say Russia needs to scrap.
RadioFreeEurope/RadioLiberty.
https://www.rferl.org/a/russia-10-laws-that-must-go/27445573.html

Caring For Orphans: Exploring the Issues behind the Russian Adoption Ban. (2013, February 5).
NACSW.
https://www.nacsw.org/caring-for-orphans-exploring-the-issues-behind-the-russian-adoption-ban/

Champenois, C. (n.d.). Does the Russian adoption ban violate international law? BYU Law
Digital Commons. https://digitalcommons.law.byu.edu/ilmr/vol11/iss2/3

Children in alternative care. (2023, May 1). UNICEF Europe and Central Asia.
https://www.unicef.org/eca/reports/children-alternative-care

Convention on the Rights of the Child. (n.d.). UNICEF.
https://www.unicef.org/child-rights-convention

Dunlevie, V. a. P. B. T. (2023, October 26). Geopolitics in the Babyhouse: How the Kremlin uses
Adopted Orphans to advance its Foreign Policy Agendas. Georgetown Security Studies
Review.
https://georgetownsecuritystudiesreview.org/2023/10/26/geopolitics-in-the-babyhouse-how-the-kremlin-uses-adopted-orphans-to-advance-its-foreign-policy-agendas/

Four principles of the Convention on the Rights of the Child. (n.d.). UNICEF.
https://www.unicef.org/armenia/en/stories/four-principles-convention-rights-child

Hartog, E. (2024, January 5). Bargaining chips: Why Russian orphans might become political
pawns once again. The Moscow Times.
https://www.themoscowtimes.com/2017/01/26/bargaining-chips-why-russian-orphans-might-become-political-pawns-once-again-a56941

Intercountry adoption. (n.d.). UNICEF. https://www.unicef.org/media/intercountry-adoption

Kim, J. (n.d.). Russian adoption ban and its impact on children and families. Center for Advanced
Studies in Child Welfare. https://cascw.umn.edu/spa/russianadoptionban/

Key recommendations on the reform of Ukraine's child protection and care system. (2023, June
15). Human Rights Watch.
https://www.hrw.org/news/2023/06/15/key-recommendations-reform-ukraines-child-protection-and-care-system

Lcsw, A. M. (2019, September 14). How Parents Fighting Could Affect a Child's Mental Health. Verywell Family. https://www.verywellfamily.com/how-parents-fighting-affects-children-s-mental-health-4158375#:~:text=Parental%20conflict%20has%20been%20linked,difficulty%20in%20adjusting%20to%20school

NEWS WIRES. (2013, June 18). Russian MPs vote to ban adoption for gay couples abroad. France 24. https://www.france24.com/en/20130618-russia-parliament-vote-ban-adoption-gay-couples-abroad-putin-marriage

OHCHR. (n.d.). Convention on the Rights of the Child. https://www.ohchr.org/en/instruments-mechanisms/instruments/convention-rights-child

Penny, L. (2017, December 1). Russia's ban on US adoption isn't about children's rights. The Guardian. https://www.theguardian.com/commentisfree/2012/dec/28/russia-ban-us-adoption-children-rights

Russia: Reject adoption ban bill. (2020, October 28). Human Rights Watch. https://www.hrw.org/news/2012/12/21/russia-reject-adoption-ban-bill

Sanctions and their impact on children. (2022, February 1). UNICEF Office of Global Insight & Policy. https://www.unicef.org/globalinsight/reports/sanctions-and-their-impact-children

Sifferlin, A. (2012, December 28). Russia's adoption politics: defeated families caught in a diplomatic tailspin | TIME.com. TIME.com. https://healthland.time.com/2012/12/28/russias-adoption-politics-defeated-families-caught-in-a-diplomatic-tailspin/?iid=tsmodule

Smith, J. (2021). "Continued Advocacy and Support for Children: Long-term Strategies." Child Rights Journal, 25(2), 180-195

Smith, J. (2018). "Creating Awareness and Mobilizing Support for Policy Change: Strategies for Advocating Against the Ban." Journal of Advocacy and Policy Change, 12(2), 145-160

Smith, J. (2016). "The Impact of Geopolitical Tensions on International Adoptions: A Case Study of Russia's Ban." Journal of Child Welfare, 22(3), 215-230.

Smith, J. (2020). "Transnational Foster Care Programs: Alternative Solutions to Adoption Restrictions." International Journal of Child Welfare, 18(4), 320-335.

Solash, R. (2013, January 11). Russian adoption ban: One U.S. family counts its blessings while others fight on. RadioFreeEurope/RadioLiberty. https://www.rferl.org/a/russian-adoption-ban-us-families-fighting-on-alina/24820229.ht

Tobin, J., Alston, P., Archard, D., Barrett, D., Besson, S., & Byrne, B. (2019). The UN Convention on the Rights of the Child: a commentary. In Oxford University Press eBooks. https://ci.nii.ac.jp/ncid/BB28109652

Traster, T. (2013, July 31). Film becomes tool for advocacy over Russian adoption ban. HuffPost. https://www.huffpost.com/entry/film-becomes-tool-for-adv_b_3366926

UN Committee on the Rights of the Child (CRC), General comment No. 14 (2013) on the right of the child to have his or her best interests taken as a primary consideration (art. 3, para. 1),

29 May 2013, CRC /C/GC/14, available at: https://www.refworld.org/docid/51a84b5e4.html

UN Committee on the Rights of the Child (CRC), UN Committee on the Rights of the Child: Concluding Observations: Russian Federation, 10 November 1999, CRC/C/15/Add.110, available at: https://www.refworld.org/docid/3ae6aecb1c.html

SeaWorld: a Case Study of Crisis-Framing Public Relations Strategy By Bruce Zhong

What is a theme park to do when faced with the question, "Are your tanks filled with orca tears?" (Woods 6) SeaWorld's response illustrates the consequences of ineffective communication strategies in the face of a legitimacy crisis.

First founded in 1964, SeaWorld rapidly became the primary source of marine life education for many American families (Iluzada and Waller 218). However, this early success did not last forever. The 2013 nature documentary *Blackfish* narrates the tale of Tilikum, an orca at SeaWorld who killed several people while captive. Using powerful anthropomorphism, the film creates an emotional bond with viewers by attributing human emotions to the orcas in what is known as the *Blackfish* effect, creating a compelling case against the captivity of orcas.

After *CNN* began streaming the documentary, it reached an audience of 21 million, pushing the orca captivity controversy into the American limelight (Duhon et al. 11). In the following years, SeaWorld saw its attendance decrease by over one million, its income drop by 84%, and its share price fall by 33% (Boissat et al. 1181). SeaWorld's crisis-framing strategies, in the face of this sudden exigency, lacked credibility and failed to resolve the crisis.

SeaWorld utilized an aggressive posture to counteract the *Blackfish* effect. Following the documentary's release at the Sundance Film Festival, SeaWorld posted a detailed rebuttal of the film, attacking the credibility of its sources (Duhon et al. 12). After the feature debuted in theatres, SeaWorld launched a new section on its website with a letter titled "Truth About *Blackfish*" (13). In the letter, SeaWorld asserted that the movie is propaganda, as "*Blackfish* used false and misleading points to manipulate viewers emotionally" (Muskat et al. 6). To expand the letter's reach, the theme park also published it on SeaWorld's social media and in national newspapers.

Communication experts offer insight into why SeaWorld's public relations approach–referred to by experts as "two-way asymmetrical communications"–failed to move the public in its favour. Ashley Pierce at the California Polytechnic State University defines two-way asymmetrical communication as a public relations model whereby the organization announces their ideas without engaging in discussions to consider the public's preferences (4). By contrast, she defines two-way symmetrical communication as a model wherein the organization has these discussions with the public and makes changes accordingly (4). Pierce also explains why using the former instead of the latter was the most significant miscalculation SeaWorld made.

By attacking all opposition, SeaWorld also rejected the opinions of anyone with genuine concerns or confusion (Pierce 11). This assertive front isolated the organization from the general population. SeaWorld's refusal to interact with criticism–going so far as to delete posts on its Facebook page that disapproved of SeaWorld's policies–further fostered a negative opinion of the park among the American public (10). Several long-term partners, including Southwest Airlines, the Miami Dolphins, and numerous well-known musical acts, discerned this negative opinion and quickly ended their partnerships with SeaWorld (Parsons and Rose 76).

Following the failure of its asymmetric communication tactics, SeaWorld attempted two-way symmetrical communication in 2015 with a Twitter campaign titled "#askSeaWorld"

(Pierce 11). However, this failed to connect with the public due to preexisting negative public attitudes towards SeaWorld after its earlier failed communication strategies.

People for the Ethical Treatment of Animals (PETA) spammed the hashtag, denying anybody with a genuine question the chance to have their inquiry answered. Chelsea L. Woods, an assistant professor at Virginia Tech's School of Communication, adds that instead of shifting public opinion in its favour, "#askSeaWorld" simply became a platform for morality-driven criticism of SeaWorld practices (1). Woods further explains that organizations with low legitimacy, such as SeaWorld, may engage in harmfully excessive efforts to protect legitimacy (8). She articulates that SeaWorld fell victim to the "overreacting factor," whereby an organization overreacts to a threat to its legitimacy, thereby conceding the validity of the threat (8). In this case, the detrimental impact of the overreacting factor was starkly clear: the rate of negative online mentions for SeaWorld rose from 55% following the *Blackfish* premiere to 90% after the #askSeaWorld Twitter campaign (10).

As society becomes increasingly digitalized, it is essential to understand that SeaWorld's *Blackfish* controversy is more than just an example of poor public relations policy. Ashli Q. Stokes and Wendy Atkins-Sayre, associate professors of communication studies at UNC Charlotte and the University of Southern Mississippi, respectively, note that "it is also one of the clearest examples of digital activists disrupting an opponent's narrative" (3).

Perhaps most importantly, the film provided PETA, a long-time opponent of SeaWorld, the ammunition to make a move against the corporation. Using *Blackfish* as its primary source, PETA utilized digital activism to force SeaWorld to overreact (34). Christina L. Illuzada and Randall L. Waller, clinical associate professors of business communication at the Hankamer School of Business at Baylor University, corroborate that the controversy was an immense success for PETA as they were able to frame SeaWorld as intent on exploiting its orcas, traumatizing the animals in the process (233).

Even though SeaWorld and PETA used similarly hostile framing tactics, mainly attacking each other's credibility, PETA's framing was more successful for several reasons. Illuzada and Waller explain that specific framing strategies are more effective than others due to "cultural resonance, fitting the audience's values, notions, and habitual ways of thinking" (237). In this case, American society considered PETA more credible because its version of the truth came with an emotive film that connected with viewers (237). On the other hand, SeaWorld seemingly failed to consider the shifting preferences of its consumer base. Calling the cast of *Blackfish* "activists" did little to discredit their message to society, given that more than 60% of people expect corporations to uphold animal rights (237).

Many researchers have shared their opinions on what SeaWorld could have done differently to achieve a better result in the national-scale framing contest. According to a study conducted by a group of researchers at the World Cetacean Alliance, people's primary motivation for visiting SeaWorld San Diego between 2015 and 2019 was to educate their children (Hockenhull et al. 78). To capitalize on this, Pierce argues that SeaWorld should find a more credible, authentic spokesperson who can deliver the organization's message about educating the public in a way that connects with the audience through two-way symmetrical communication (14). Pierce adds that it would be advantageous to use a scientist, for example, compared to the

Vice President of Communications, to respond to tough questions and criticisms because they could provide genuine answers without falling into the trap of spurious corporate speak (14).

Woods corroborates that technical justifications resonate with some audiences but tend to be "less effective at safeguarding legitimacy than institutional responses, [emphasizing] that the organization engages in normative practices" (9). Woods adds that given the impact of digital activism in modern society, it may have been advantageous for SeaWorld to take discussions with hostile critics offline to avoid these disputes escalating into national debacles through online media (10). By privately engaging with opponents, SeaWorld could use its public platform to convey its message directly to its target audience: the American public.

There were many things SeaWorld could have done when faced with the question, "Are your tanks filled with orca tears?" Among other approaches, SeaWorld could have conveyed its importance to the public using two-way symmetrical communication methods, emphasizing education and conservation. Additionally, had SeaWorld taken discussions with direct opposition offline, the company may have prevented the controversy from becoming a national debacle and mitigated the overwhelming success of PETA's digital activism.

Despite these options, SeaWorld used aggressive asymmetric communication to attack all opposition directly. When the corporation finally resorted to engaging in honest conversations about people's concerns, the public no longer welcomed these discussions due to SeaWorld's previous hostile overreactions that delegitimized the corporation. Ultimately, SeaWorld's *Blackfish* controversy is an example for future public relations practitioners to learn from when facing a legitimacy crisis.

Works Cited

Boissat, Laure, et al. "Nature Documentaries as Catalysts for Change: Mapping out the "Blackfish Effect."" *People and Nature*, vol. 3, no. 6, 6 June 2021, pp. 1179–1192. *British Sociological Society*, https://doi.org/10.1002/pan3.10221.

Duhon, Stefani, et al. "A Whale of a Problem: A Strategic Communication Analysis of SeaWorld Entertainment's Multi-Year Blackfish Crisis." *Case Studies in Strategic Communication*, vol. 5, no. 1, 2016, pp. 3–37. *CSSC,* http://cssc.uscannenberg.org/wp-content/uploads/2016/08/v5art2.pdf.

Hockenhull, Jo, et al. "Using the COM-B Model to Explore the Reasons People Attended Seaworld San Diego between 2015 and 2019." *Tourism in Marine Environments*, vol. 17, no. 1, 29 July 2022, pp. 69–83. *Ingenta Connect*, https://doi.org/10.3727/10.3727/154427322x16532010643135.

Iluzada, Christina L., and Randall L. Walle. "*Blackfish* and SeaWorld: A Case Study in the Framing of a Crisis." *International Journal of Business Communication*, vol. 57, no. 2, 1 Nov. 2019, pp. 227–243. *Sage Journals*, https://doi.org/10.1177/2329488419884139.

Parsons, E. C. M., and Naomi A. Rose. "The Blackfish Effect: Corporate and Policy Change in the Face of Shifting Public Opinion on Captive Cetaceans." *Tourism in Marine Environments*, vol. 13, no. 2, 16 Aug. 2018, pp. 73–83. *Ingenta Connect*, https://doi.org/10.3727/154427318x15225564602926.

Pierce, Ashley. "SeaWorld and the Blackfish: The Lack of Two-Way Symmetrical Communication and Finding the Correct Message." June 2015, pp. 1-76.

Stokes, Ashli Q., and Wendy Atkins-Sayre. "PETA, Rhetorical Fracture, and the Power of Digital Activism." *Public Relations Inquiry*, vol. 7, no. 2, May 2018, pp. 1-52. *Sage Journals*, https://doi.org/10.1177/2046147x18770216.

Woods, Chelsea L. "'Are Your Tanks Filled with Orca Tears?': Crisis Frames and Message Convergence in SeaWorld's Tanked Twitter Campaign." *Corporate Reputation Review*, vol. 21, no. 1, 26 Oct. 2017, pp. 1-13. *Springer Link*, https://doi.org/10.1057/s41299-017-0039-y.

Design and characterization of a novel wheelchair utilizing a swerve drive drivetrain for holonomic motion

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6/August/2023

Introduction

Mobility is a critical aspect of daily life, and for people with limited mobility, it can be challenging to perform even the most basic tasks. Wheelchairs are the solution to this problem. Wheelchairs are mobility aids that provide people with disabilities or injuries with a means to move around more easily and independently. They enable individuals to participate in various activities, from running errands and attending social events to simply moving around their home. Wheelchairs come in a variety of designs and configurations, each tailored to meet the specific needs of the user. Whether manual or power-assisted, wheelchairs are an essential tool for many people with disabilities, enabling them to maintain their independence and mobility.

Given the importance of drivetrains in enabling the movement of wheelchairs, wheelchair drivetrains are a crucial component for mobility aids designed for individuals with limited mobility. Whether manual or power-assisted, wheelchairs require a drivetrain to enable movement by transferring power from a motor or hand to the wheels while also controlling speed and direction. While conventional wheelchair technology has been around for centuries, there have been several advancements in wheelchair drivetrain technology. Electric wheelchairs have been in use since the 1930s, and manual wheelchairs have been in use for even longer (DiGiovine). Manual powered wheelchairs require the user to manually propel the chair using their upper body strength, which may be difficult for some. Power-assisted wheelchairs, on the other hand, use electric motors and batteries to provide assistance to the user in propelling the chair, making them more suitable for people who have limited upper body strength.

However, one common flaw that is apparent in current electric wheelchair models is that they utilize a non-holonomic drivetrain, meaning that all of the current models can only move forward, backwards, and turn. However with this novel concept, it is possible to allow for strafing and omni-directional movement.

An example of a situation where this form of drivetrain is more efficient than conventional design is in tight and crowded spaces, such as narrow hallways, doorways, or elevators. In these situations, a non-holonomic drivetrain can be limiting, as it requires the user to make multiple point turns in order to change direction. This can be time-consuming and can make it difficult to navigate through tight spaces.

In contrast, a holonomic drivetrain, which allows for strafing and omni-directional movement, can offer greater maneuverability and efficiency in these situations. It enables the user to move in any direction without having to make multiple point turns, making it easier to navigate through tight spaces and avoid obstacles.

The Goal

With the context established, the focus of this research paper lies in the "Design and characterization of a novel wheelchair utilizing a swerve drive drivetrain for holonomic motion."

Literature Review

Pre-Existing Electric Wheelchair Designs

An electric wheelchair is a mobility device, initially created in the 1900s, designed to provide individuals with limited mobility the ability to move around independently. It utilizes electric power to propel and control the wheelchair, reducing the physical effort required for propulsion compared to manual wheelchairs. It typically consists of an electric motor or motors, a battery pack, and a controller. The electric motor drives the wheels, allowing the wheelchair to move forward, backward, and turn (DiGiovine).

Existing electric wheelchair design

Figure 1

The use of an electric wheelchair provides individuals with limited mobility the freedom and independence to navigate their environment more easily. It allows them to move around their homes, access public spaces, engage in social activities, and perform daily tasks with greater autonomy. Electric wheelchairs offer a range of benefits, including reduced physical exertion, improved maneuverability, and enhanced comfort, ultimately contributing to an improved quality of life for wheelchair users.

Numerous electric wheelchair designs have been developed to improve mobility and independence for individuals with mobility impairments. These designs vary in terms of their features, capabilities, and user-friendliness. One example of an advancement in wheelchair drivetrain technology is a power-assisted wheelchair that utilizes infrared sensors to trigger two Brushless DC hub motors (Hou et al.). This technology, discussed in a paper published in the 2012 IEEE Transportation Electrification Conference and Expo (ITEC), eliminates the need for torque sensors or pressure transducers to measure and amplify human force, enhancing the control and maneuverability of the wheelchair.

Additionally, a different control scheme for joystick-controlled wheelchairs has been proposed in a paper published in the International Research Journal of Engineering and Technology (IRJET). This alternative control scheme offers the potential to improve the controllability and independence of physically challenged individuals (Saharia et al.). These advancements in drivetrain technology and control schemes contribute to the continuous evolution of electric wheelchair designs, aiming to provide individuals with enhanced mobility options and improved user experiences.

All of these approaches have proven to be useful and beneficial to individuals with mobility impairments, providing them with improved mobility options and greater independence. However, it is important to acknowledge that while these advancements have addressed various aspects of wheelchair design, they have not fully addressed the greatest flaw inherent in traditional wheelchair mobility: its limited maneuverability. Despite the advancements in drivetrain technology and control schemes, conventional wheelchairs often face challenges

when it comes to navigating in tight spaces, making sharp turns, or maneuvering through crowded environments. This limitation can restrict individuals' ability to access certain areas or engage in daily activities with ease, potentially hindering their overall mobility and independence.

Holonomic Drive

One promising solution to improve manageability for conventional wheelchair designs is the development of holonomic drivetrains for wheelchairs. The concept of holonomic drive is a significant point of attention in electric wheelchair design due to its potential to enhance maneuverability.

Holonomic drive refers to a type of drivetrain system that enables a vehicle, including wheelchairs, to have omnidirectional movement capabilities. Unlike traditional drivetrains that rely on forward and backward propulsion with limited turning ability, holonomic drive systems allow for movement in any direction without the need for reorientation ("Robot Platform | Knowledge | Holonomic vs. Non-Holonomic").

The key feature of a holonomic drive system lies in its wheel configuration. Instead of using standard wheels that rotate in a single direction, holonomic drive systems utilize omnidirectional wheels or a combination of traditional wheels and multidirectional casters. These specialized wheels are designed to rotate independently, enabling the wheelchair to move laterally, diagonally, or rotate in place. There are many specialized drive systems that allow for holonomic motion these include the mecanum drive, omni wheel drive, and swerve drive ("Holonomic Movement").

The mecanum drive system utilizes a set of mecanum wheels, which consist of small angled rollers

around the circumference of the wheel. These rollers allow the wheels to move in any direction and rotate independently. By controlling the speed and direction of each wheel, the mecanum drive system enables the wheelchair to achieve omnidirectional movement and precise maneuverability. This drive configuration is particularly useful for applications that require both lateral and diagonal movements, providing enhanced versatility in navigating complex environments ("How a Mecanum Drive Works").

Wheelchair using mecanum wheels

Figure 2

Omni wheel drive systems employ specialized wheels known as omni wheels or omni-directional wheels. These wheels have small rollers mounted at right angles to the main wheel, allowing them to rotate independently. By arranging multiple omni wheels in a specific configuration, such as a mecanum or H-drive arrangement, the wheelchair can move in any direction without changing its orientation. Omni wheel drive systems are known for their stability, smooth

Triple Rotacaster commercial industrial omni wheel

Figure 3

movement, and ability to perform precise turns (Using Omni Wheels to Make Holonomic Drive).

Swerve drive, also known as independent wheel drive or turret drive, is a drivetrain configuration that combines traditional wheels with individual steering modules. Each wheel is independently mounted on a mechanism that can rotate and change direction. By controlling the rotation and orientation of each wheel module, the swerve drive system enables the wheelchair to move in any direction and perform precise rotations. Swerve drive systems offer exceptional maneuverability and allow for smooth transitions between different movement vectors. (Project Robotica).

Diagram of a pre-existing swerve module

Figure 4

The advantage of a holonomic drive system is its enhanced maneuverability. A holonomic drive system allows wheelchair users to move in any direction without needing to change its orientation. These drivetrain systems enable wheelchair users to navigate through tight spaces, perform precise and smooth turns, and change directions seamlessly, even in crowded or confined environments (Shah).

Holonomic drive systems can be controlled using various input devices, such as joystick controls or touchpads, allowing users to intuitively command the wheelchair's movement (Trinayan) Additionally, advanced control algorithms and sensors can be incorporated to provide obstacle detection and avoidance capabilities, further enhancing the safety and usability of the holonomic drive system.

While holonomic drive systems offer significant advantages in terms of maneuverability, it is important to note that they may have certain limitations. For example, they may require additional power compared to traditional drivetrains due to the complexity of controlling multiple independently rotating wheels. Along with increased chances of malfunction due to a greater amount of moving parts, and more complex driving algorithms (Abhinav).

Overall, holonomic drive systems provide an innovative and effective solution to improve the maneuverability of wheelchairs. By enabling omnidirectional movement, these systems enhance the user's freedom of mobility, allowing them to navigate their surroundings with greater ease, efficiency, and independence.

Methodology

The process of creating this innovative design required an extensive amount of groundwork. This began with prior research, which entailed a comprehensive literature review of pre-existing designs. I also studied the current state of wheelchair drivetrains and performed a qualitative analysis on user

requirements to ascertain the exact needs we had to meet. This information is described in the "pre-existing designs of wheelchairs" section.

The next phase was the design stage. Here, I conducted research on examples similar to the novel drivetrain I was developing. This allowed me to gain a deeper understanding of how the system works and using this information I was able to redesign and recreate the design in CAD.

In addition I researched on drivetrain algorithms, specifically for holonomic drive trains, this information was crucial for the implementation of this algorithm in the code. The electrical design aspect was also explored at this stage.

Following the design phase, was the production phase. This involved sending the CAD files for manufacturing and waiting for the parts to be produced. As well as searching for and gathering the necessary materials was an integral part of this process. Upon receiving the parts, they had to be assembeled. Soldering and assembling the electrical parts was a meticulous process that required both precision and care.

Coding was the subsequent stage, it involved implementing the holonomic drive train algorithm, along with logic for the optimal turning of the wheels. This was followed by tuning, which required a high degree of expertise and attention to detail. The next logical step in the process was experimentation, which involved defining exact experiments to conduct, carrying out these trials, and gathering data.

The final phase was assessment. In this stage, a comparison between the novel design and current wheelchair designs was conducted. It was crucial for us to understand where the novel design stood in terms of improvements and innovations, as well as to identify areas that may require further refinement.

Design and Development

What is Coaxial Swerve?
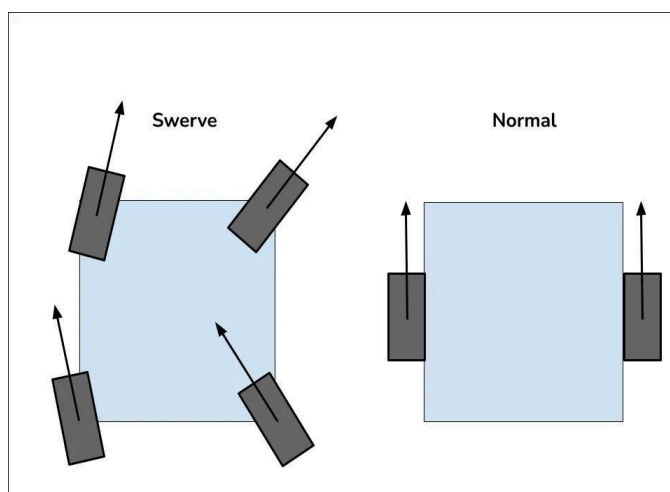
A coaxial swerve drive, also known as a crab drive, is a specific type of drivetrain used in robotics, particularly in competitive robotics like FRC (FIRST Robotics Competition). In a coaxial swerve drive, each wheel is independently steerable and drivable, allowing the robot to move in any direction without changing its orientation (Project Robotica).

Diagram of how swerve allows for holonomic motion

Figure 5

The key technology in a coaxial swerve drive is the use of bevel gears. Bevel gears are a type of gear where the axes of the two shafts intersect and the tooth-bearing faces of the gears themselves are conically shaped. This makes them ideal for transmitting motion between non-parallel shafts. In a coaxial swerve drive, a pair of bevel gears is used to transfer power from a drive motor (which is usually oriented vertically) to the wheel (which is oriented horizontally) (Project Robotica).

The "coaxial" part of a coaxial swerve drive refers to the configuration of the drive and steering shafts. These shafts are arranged along the same axis (i.e., they are "coaxial") with the drive shaft passing through the hollow center of the steering shaft. This allows the drive motor to power the wheel while the steering motor changes the wheel's direction. The advantage of this design is that it simplifies the mechanical complexity of the drive system and reduces the size of each drive module (Project Robotica).

Photo of a pre-existing swerve module

Figure 6

The Design

Based on the aforementioned principles of coaxial swerve drive, a design can be constructed drawing inspiration from existing designs that have been developed based on the principles of this drivetrain configuration. Through literature review and understanding of the system a 3D CAD model was constructed. However, several iterations were necessary to tailor the design to meet the specific requirements and preferences of wheelchair users.
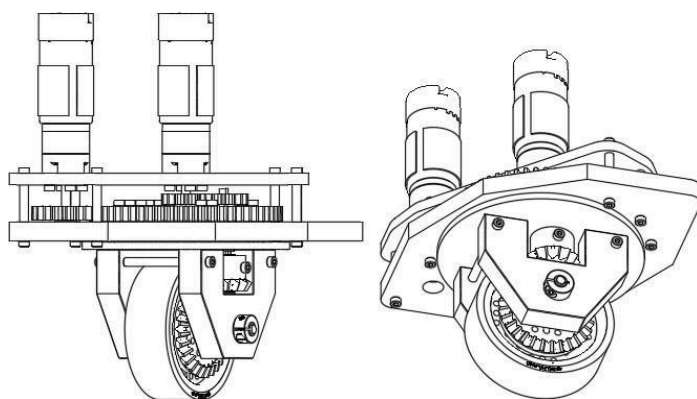
Figure 7

Drawing of the 3D modelled Swerve Module design

One common aspect found in some previous designs is the inclusion of an extra set of gears. These gears were employed to align the motors with the center of the module, ensuring balance and proper functioning. However, it is important to note that in certain cases, such

as when the module is mounted to a large plate and equipped with multiple wheels for added stability, the inclusion of an extra set of gears may not be necessary. By eliminating this additional gear set, several advantages can be achieved. The removal of an extra set of gears results in a reduction in size, weight, and cost. This can be particularly advantageous for wheelchair applications, where compact and lightweight designs are highly desired. The decreased size and weight enable easier integration of the coaxial swerve drive system into the wheelchair frame, without compromising its structural integrity or adding unnecessary bulk. Cost reduction also becomes a significant benefit. The elimination of extra gears translates to lower production expenses, as there are fewer custom components to manufacture and assemble. This can contribute to making the overall design more affordable and accessible.
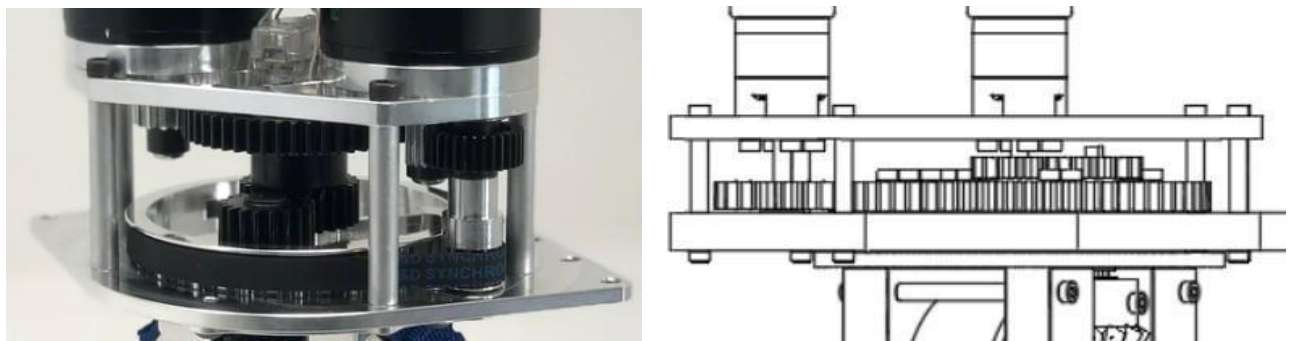
Gear system of conventional design and created design side by side

Figure 8

Another advantage lies in the reduced points of failure. Each additional gear introduces the possibility of mechanical wear, misalignment, or failure. By eliminating unnecessary gears, the overall reliability and durability of the swerve drive system can be enhanced. This leads to improved performance and decreased maintenance requirements, providing wheelchair users with a more dependable mobility solution.

However, it is crucial to ensure that the design adequately compensates for the absence of the extra gear set. Proper weight distribution, structural reinforcement, and alignment adjustments should be considered during the design process to maintain the module's balance and stability.

The Swerve Algorithm
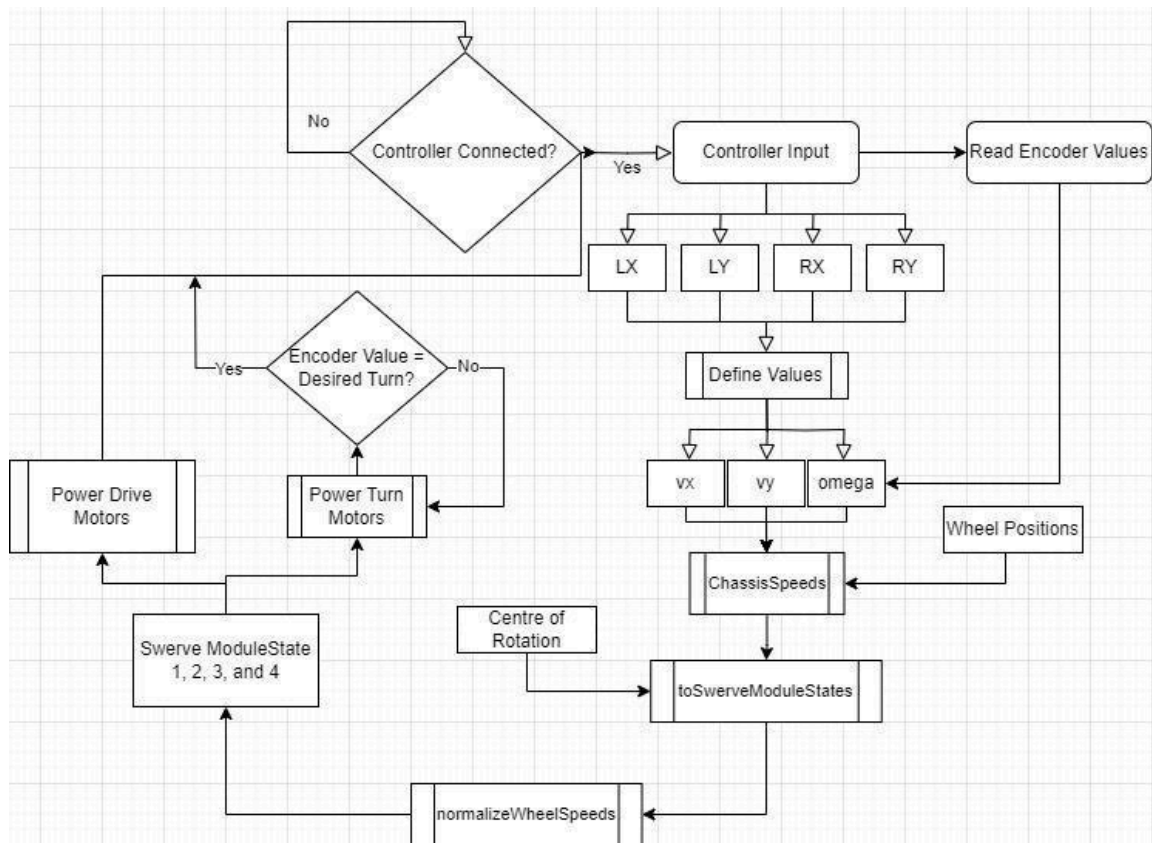
Swerve algorithm flowchart

Figure 9

The Swerve Algorithm operates in an iterative cycle, continuously reading data from a multitude sensors or input sources. These sources include reading the current angle/heading of the wheels based on encoder feedback and the current position of the two joysticks on the controller.

This collected data is then processed by the Define Values algorithm, this algorithm assimilates the controller and encoder values, translating them into components of movement: the velocity in the x-direction, the velocity in the y-direction, and rotational speed, denoted as omega.

These calculated values serve as inputs to the 'wiplibary', this library houses the kinematics equations essential for swerve holonomic drive. This library serves as the brain of the operation, outputting the individual module states, the requisite direction each module should face, and the optimal speed to achieve the desired trajectory ("WPILib API — RobotPy WPILib 2023.4.3.0 Documentation").

The final segment of this intricate code is the implementation of these computed values into the modules themselves. This crucial step translates the velocity from meters per second into the corresponding motor voltage, and the desired direction is executed by running the motor from its current encoder position until it reaches the desired one.

The loop then repeats itself, changing velocity and direction each time a new controller input is recorded.

Code Implementation

The code will be run on a Raspberry Pi, coupled with an adafruit HAT DC motor controller, this can be used to control the motors atop a coaxial swerve drive module.

The Raspberry Pi is a small, low-cost computer that will be programmed using languages like Python. It has GPIO (General Purpose Input/Output) pins that can be used to send and receive digital signals to and from various hardware devices, such as a motor controller.
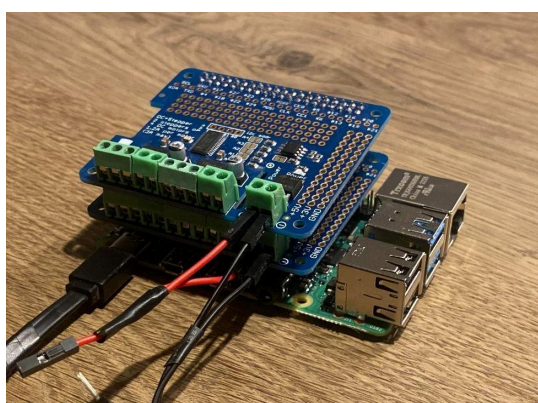
The adafruit HAT acts as a motor controller which is an electronic device that is used to manage the speed, direction, and other aspects of an electric motor. It works by receiving signals from a control system, such as a computer or a human operator, and using those signals to adjust the voltage or current that is supplied to the motor ("Adafruit DC and Stepper Motor HAT for Raspberry Pi.").

Raspberry **Figure 10** HAT

With these abilities, a motor controller can start and stop the motor, controlling its speed, this when coupled with an encoder lets the motor act like a servo. This is essential for the fundamentals of the coaxial drive as one of the motors needs to be able to control which direction the wheel is facing, while the other motor must have variable speed to control the horizontal movement speed.

This in combination with the swerve algorithm will allow the wheelchair to achieve holonomic motion, enabling it to move in any direction with ease and precision.

Results

In this paper, I evaluated the effectiveness of the completed holonomic swerve drive technology (Shown in figures 11, 12, and 13) in comparison to traditional non-holonomic drive train systems. The results obtained from my research is detailed below.

Figure 11

Figure 12
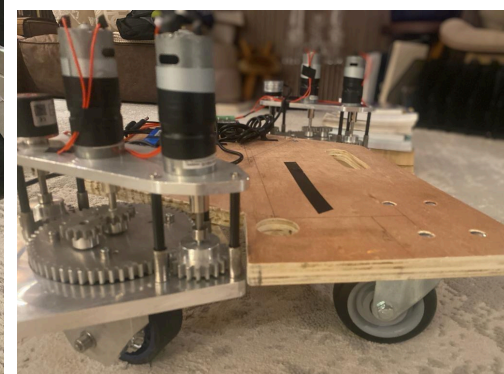
Figure 13

Performance of Holonomic Swerve Drive Wheelchairs

To measure the limitations and potential of a swerve drivetrain for wheelchair application, a few aspects of the design must be tested in different situations to determine effectiveness. Multiple different situations were tested to determine, the Maneuverability and Turning Radius, the Speed and Power, the Pre-programmed Pathing Capabilities, and the Safety and Stability. Additionally, a survey was conducted to determine ease of use and user experience, and an analysis was done on the cost benefit comparison in constructing this design.

This theory was tested by using the prototype drivetrain in 2 different modes to compare traditional non-holonomic drivetrain systems to the novel swerve drive holonomic drivetrain.
The differentiation between these modes would be that one mode allows for holonomic motion, while the other immitates the type of motion that can be seen on an existing electric wheelchair. This was accomplished through locking the y axis, preventing the module from free rotation, and restricting its movement to a single plane. By doing so, the module's motion was constrained to only forward and backward translation and turning, similar to the movements of a traditional
non-holonomic drivetrain.

The purpose of comparing these two modes was to evaluate the advantages and disadvantages of the swerve drive holonomic drivetrain. By observing the performance of the prototype drivetrain in both modes, researchers could assess its maneuverability,

capabilities, safety, and overall effectiveness in different scenarios

 Maneuverability:

The swerve drive wheelchair's primary advantage lies in its improved maneuverability, which allows the wheelchair to move in any direction without turning. We will test its turning radius and strafing capabilities.

Mode 1: Locked Y Axis replicating typical wheelchair drivetrain
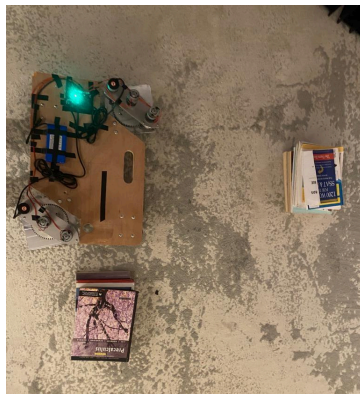
Figure 14
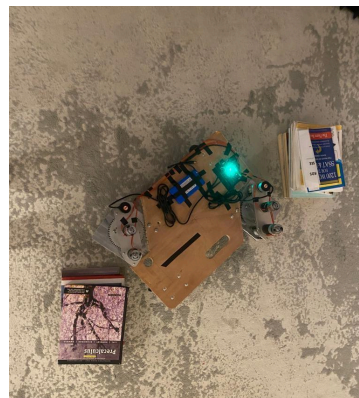
Figure 15
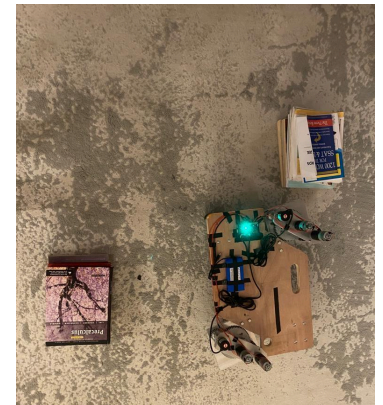
Figure 16

Trial no.	Seconds to complete obstacle course
1	8.56 seconds
2	9.92 seconds
3	9.23 seconds
Average Time to complete	9.24 seconds

Mode 2: Utilisation of holonomic motion through swerve drive
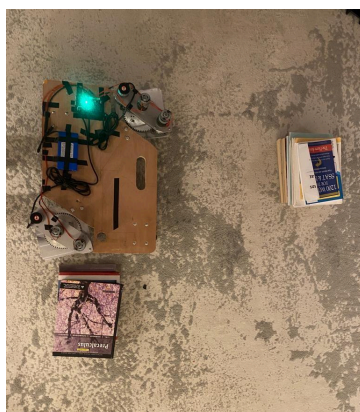
Figure 17
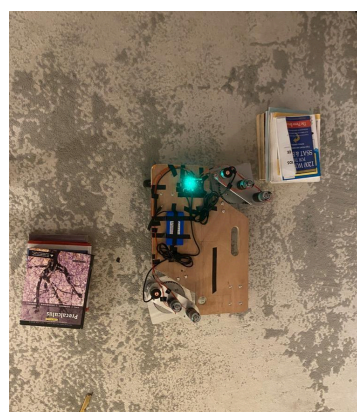
Figure 18
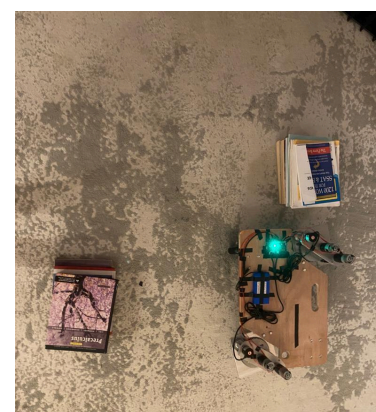
Figure 19

Trial no.	Seconds to complete obstacle course
1	5.84 seconds
2	6.35 seconds
3	5.27 seconds
Average Time to complete	5.88 seconds

The data indicates the time taken by the swerve drive wheelchair to navigate through an obstacle course in Mode 1 and Mode 2. The time recorded was approximately 9.24 seconds on average for Mode 1 and 5.88 seconds on average for Mode 2.

Mode 1 (Non-Holonomic Motion): The wheelchair in Mode 1, which imitated the motion of a traditional non-holonomic electric wheelchair, took approximately 9.24 seconds to complete the same obstacle course. This longer time indicates that the non-holonomic motion restricted the wheelchair's maneuverability, thereby slowing down its progress through the course.

Mode 2 (Holonomic Motion): The swerve drive wheelchair in Mode 2 completed the obstacle course in approximately 5.88 seconds. This suggests that the holonomic motion allowed the wheelchair to maneuver through the course more quickly and efficiently. The ability to move in any direction without turning likely contributed to its faster completion time.

These results imply that the swerve drive wheelchair's holonomic motion in Mode 1 offers advantages in terms of maneuverability when navigating an obstacle course. The ability for omnidirectional motion allows for quicker and more efficient maneuvering around obstacles, resulting in a faster completion time compared to the non-holonomic motion in Mode 2.

Turning radius:
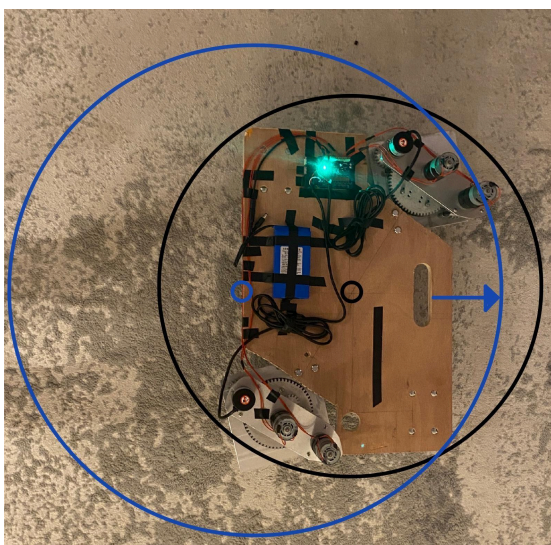
Figure 20

The turning radius of a wheelchair refers to the minimum radius at which it can successfully rotate without difficulty. In traditional wheelchairs, the center of rotation is typically located at the back wheels.

However, with the new swerve drive design, the center of rotation can be customized and placed according to the user's needs, allowing for increased maneuverability.

When the center of rotation is placed at the center of the wheelchair, indicated with the black circle in figure 20, the turning radius is approximately 34cm. This indicates that the wheelchair can execute sharp turns and navigate through tight spaces more effectively when the center of rotation is located at the center.

When the center of rotation is placed between the hind wheels, indicated with the blue circle in figure 20, the turning radius increases to approximately 53cm. This larger turning radius suggests that the wheelchair requires more space to execute turns and maneuver in confined areas when the center of rotation is positioned between the hind wheels.

The data demonstrates that by customizing the placement of the center of rotation, the swerve drive wheelchair offers allows for a smaller turning radius, enabling the wheelchair to navigate tight spaces and execute sharp turns more efficiently, allows for the ability to optimize the turning radius according to the user's requirements.

Speed and Power:

100RPM DC motors used in swerve module

Figure 21

The maximum speed of the swerve drive wheelchair prototype was recorded at half a meter per second. This speed was limited by the RPM (rotations per minute) of the motor used in the prototype.

Comparing this speed to pre-existing electric wheelchairs on the market, it is important to note that electric wheelchairs typically have varying speed ranges depending on the model and intended use. However, a common range for electric wheelchairs can be around 4-8 miles per hour (approximately 1.8-3.6 meters per second).

Based on this comparison, the swerve drive wheelchair prototype's maximum speed of half a meter per second appears to be relatively slow in comparison to the typical speeds of pre-existing electric wheelchairs. This suggests that there is a need for improvement in the speed and power capabilities of the prototype.

To enhance the speed and power of the wheelchair, it would be necessary to consider motors with higher RPM capabilities. By utilizing motors that can achieve higher rotational speeds, the wheelchair's maximum speed can be increased, resulting in improved overall performance and mobility for users. However, it is important to consider that increasing speed should not compromise safety and stability, which are crucial factors in wheelchair design.

Based on the provided data, the swerve drive wheelchair prototype had a relatively slow maximum speed compared to pre-existing electric wheelchairs. Improving the motor power, battery capacity, wheel configuration, and control system can potentially enhance the speed and power capabilities of the swerve drive wheelchair, providing users with a more efficient and effective mobility solution.

User Interface and Control:

The user interface and control of the swerve drive wheelchair prototype play a crucial role in its usability. The control interface consists of a controller with separate joysticks for motion and rotational speed control. The left joystick enables control of motion in all directions, while the right joystick adjusts the rotational speed. The evaluation of the user interface and control involves assessing the ease of use, intuitiveness, and adaptability of the control system.

Figure 22

During the assessment, observers had the opportunity to use the system and provide feedback. The feedback was that the control scheme was intuitive and easy to learn. This positive feedback indicates that the control interface effectively facilitated user interaction with the wheelchair, allowing for precise and responsive control.

Safety and Stability:

The wheelchair's ability to maintain stability during various maneuvers and its effectiveness in swiftly evading obstacles and preventing head-on collisions is of upmost importance. One feature of the swerve drivetrain that exhibits improved safety is the wheelchair's superior maneuverability when compared to traditional wheelchairs. By utilizing the strafing maneuver, the wheelchair demonstrated the capability to navigate around obstacles more efficiently, leading to a smoother and safer navigation experience for users.

For instance, during an obstacle course test, the swerve drive wheelchair showcased remarkable maneuverability in comparison to conventional wheelchairs. Its strafing capability allowed it to navigate around obstacles with ease, eliminating the sole reliance on backward movements. As a result, the wheelchair exhibited quicker and more efficient avoidance of obstacles, significantly enhancing the user's navigation experience in terms of both smoothness and safety.

Cost-Benefit Analysis:

In evaluating the cost-benefit aspects of the swerve drive wheelchair, it is important to consider several factors, including Hardware costs and maintenance expenses.

One significant consideration is the initial cost of the swerve drive wheelchair prototype. Each module of the swerve drive system costs approximately $220, and since there are two modules required, the total cost for the drive system alone is $440. Additionally, there is extra hardware involved, which adds approximately $150 to the overall cost. It is important to note that these prices are specific to the current prototype, and costs can vary as the design progresses and economies of scale come into effect.

While the initial cost of the swerve drive wheelchair prototype may be higher compared to a traditional wheelchair, it is crucial to assess the potential benefits and long-term savings it offers. For instance, the swerve drive wheelchair's improved maneuverability and obstacle avoidance capabilities can potentially reduce the need for caregiver assistance in certain situations. By enabling users to navigate obstacles more efficiently, the swerve drive wheelchair empowers individuals to maintain a higher degree of independence, potentially reducing the need for constant caregiver support. This reduction in caregiver assistance can

lead to long-term cost savings for individuals and healthcare systems.

Moreover, the enhanced maneuverability and functionality of the swerve drive wheelchair can contribute to improved overall mobility and quality of life for users. By offering smoother navigation, efficient obstacle avoidance, and increased maneuverability in tight spaces, the swerve drive wheelchair can enhance users' daily activities, social participation, and overall well-being. These benefits translate into improved quality of life, which is invaluable for wheelchair users.

It is also important to recognize that the current prototype is subject to further development and refinement. As prototypes are typically more expensive due to the iterative design process and smaller production quantities, it is reasonable to expect that costs may change as the design progresses and economies of scale are realized.

Future Work:
Energy Efficiency Analysis: One area of future work for the swerve drive wheelchair prototype is conducting an energy efficiency analysis. This analysis would involve measuring the power consumption of the wheelchair during different tasks and evaluating its overall energy efficiency in comparison to a traditional drivetrain. By identifying areas where energy consumption can be optimized, such as motor efficiency, battery management, or control algorithms, it would be possible to enhance the wheelchair's energy efficiency, potentially increasing its operating time and reducing the frequency of battery recharging or replacement.

Speed and Power Enhancement: As mentioned earlier, the prototype exhibited a relatively slow maximum speed compared to pre-existing electric wheelchairs. In future iterations, improving the motor power, battery capacity, wheel configuration, and control system should be explored to enhance the speed and power capabilities of the swerve drive wheelchair. This would involve researching and selecting motors with higher RPM capabilities and evaluating their compatibility with the wheelchair's design.

User Experience and Comfort: Future work should focus on improving the overall user experience and comfort of the swerve drive wheelchair. This includes considerations such as optimizing the turning radius to accommodate different user preferences.

Safety and Stability Enhancements: While the prototype demonstrated improved maneuverability and obstacle avoidance capabilities, further work is needed to enhance safety and stability. This can be achieved by implementing advanced sensor systems for collision detection and avoidance, refining the control algorithms to improve stability during abrupt movements, and ensuring the wheelchair remains stable on different surfaces and inclines. Conducting rigorous safety tests and user feedback sessions will be crucial to identify potential risks and address them effectively.

Durability and Maintenance: Given that the prototype is still in the early stages of development, future work should focus on enhancing the durability and ease of maintenance. This involves selecting robust materials, designing modular components for easy replacement and repair, and implementing preventive maintenance measures to extend the wheelchair's lifespan. Conducting long-term durability tests and gathering user feedback on maintenance requirements will provide valuable insights for further improvements.

Pre-Programmed Pathing Capabilities: An important area of future work for the swerve drive wheelchair prototype is the development of pre-programmed pathing capabilities. This feature would allow users to define and store specific routes or waypoints, which the wheelchair can autonomously follow. By incorporating pre-programmed pathing, the wheelchair can navigate predetermined paths, without requiring constant user input, fully utilising the manuverability andcontrolability of the drive system.

By addressing these areas of future work, the swerve drive wheelchair prototype can evolve into a more advanced and user-friendly mobility solution, offering enhanced performance, improved safety, and increased overall satisfaction for wheelchair users.

Conclusion

In conclusion, the development of the swerve drive wheelchair prototype represents a potential advancement in the field of mobility solutions for individuals with limited mobility. The prototype showcased improved maneuverability, obstacle avoidance capabilities, and a novel swerve drive system that enables enhanced control and versatility.

However, it is important to recognize that the prototype is still in its early stages, and there are several areas of future work that need to be addressed. These include optimizing energy efficiency, enhancing speed and power capabilities, improving user experience and comfort, ensuring safety and stability, focusing on durability and maintenance, and incorporating user-centric design iterations.

Moreover, it is crucial to acknowledge the limitations and potential sources of error in the tests conducted on the prototype. Factors such as small sample size, single testing environment, operator skill and experience, prototype limitations, measurement errors, and external factors can impact the accuracy and generalizability of the results.

With continued progress and improvements, the swerve drive wheelchair has the potential to improve the mobility experience for individuals with limited mobility. By offering enhanced maneuverability, autonomy, and user-friendly features such as pre-programmed pathing capabilities, the wheelchair can empower users and provide them with greater independence and freedom of movement.

Overall, the swerve drive wheelchair prototype represents a promising innovation in the field of mobility devices. By addressing the identified areas of future work and incorporating user feedback, a novel solution can be created that positively impacts the lives of individuals with limited mobility

Works Cited

"Adafruit DC and Stepper Motor HAT for Raspberry Pi." *Adafruit Learning System*,
27 Jan. 2015,
learn.adafruit.com/adafruit-dc-and-stepper-motor-hat-for-raspberry-pi/overvie
w. Accessed 12 Aug. 2023.

DiGiovine, Carmen P.. "electric wheelchair". Encyclopedia Britannica, 6
Feb. 2014,
https://www.britannica.com/technology/electric-wheelchair.
Accessed 19 December 2023.

"Holonomic Movement." *Linkedin.com*, 2017,
www.linkedin.com/pulse/holonomic-movement-emerson-ye. Accessed 12 Aug. 2023.

Hou, Ruoyu, et al. Design and Implementation of a Novel Power Assisted Drivetrain for a Wheelchair. June
2012, https://doi.org/10.1109/itec.2012.6243483. Accessed 19 Dec. 2023.

"How a Mecanum Drive Works." *Seamonsters-2605.Github.io*, 2023,
seamonsters-2605.github.io/archive/mecanum/. Accessed 12 Aug. 2023.

MK4 Swerve Module. "MK4 Swerve Module." *Swerve Drive Specialties*,
2023,
www.swervedrivespecialties.com/products/mk4-swerve-module.
Accessed 12 Aug. 2023.

Peri, Abhinav. "Using Inverse Kinematics to Become a Master-Swerver." *Medium*,
Medium, 20 May 2022,
abhinavwastaken.medium.com/using-inverse-kinematics-to-become-a-master-swerv
er-1026759d81b0. Accessed 12 Aug. 2023.

Project Robotica. "About FTC Swerve Drivetrains - Project Robotica." *Project Robotica*, Project Robotica,
20 Apr. 2023, projectrobotica.wiki/wiki/FTC:Swerve_Drivetrains. Accessed 12 Aug. 2023.

Rascal P327XL Electric Wheelchair. "Rascal P327XL Electric Wheelchair."
Active Mobility Ltd, 2021,
activemob.co.uk/products/rascal-p327xl-electric-wheelchair.
Accessed 12 Aug. 2023.

"Robot Platform | Knowledge | Holonomic vs. Non-Holonomic." *Robotplatform.com*,
2023,
www.robotplatform.com/knowledge/Classification_of_Robots/Holonomic_and_
Non-Holonomic_drive.html. Accessed 12 Aug. 2023.

Saharia, Trinayan, et al. "JOYSTICK CONTROLLED WHEELCHAIR." 2017.

"SDS MK4 Swerve Modules." *Andymark.com*, 2023,
www.andymark.com/products/mk4-swerve-modules?quantity=1.Accessed 12 Aug. 2023.

Shah, Harshil. "How to Build a Swerve-Drive Robot." *Fresh Consulting*, 24 Feb. 2023,
       www.freshconsulting.com/insights/blog/how-to-build-a-swerve-drive-robot/#:~:text=
       Swerve%2Ddrive%20is%20a
       n%20omnidirectional,Ackermann%20steering%20or%20differential%20drive.
       Accessed 12 Aug. 2023.

Using Omni Wheels to Make Holonomic Drive. 2018.

Wikipedia Contributors. "Mecanum Wheel." *Wikipedia*, Wikimedia Foundation, 24 July
       2023, en.wikipedia.org/wiki/Mecanum_wheel. Accessed 12 Aug. 2023.
"Omni Wheel." *Wikipedia*, Wikimedia Foundation, 25 Jan. 2023, en.wikipedia.org/wiki/Omni_wheel.
Accessed 12 Aug 2023.

"WPILib API — RobotPy WPILib 2023.4.3.0 Documentation." *Readthedocs.io*, 2023,
       robotpy.readthedocs.io/projects/wpilib/en/stable/api.html. Accessed 12 Aug. 2023.

Exploring the World of AI Art : Unveiling Perceptions, Adoption, and Impacts of Text-to-Image Generation Models in Artistic Innovation

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Abstract

Embracing the transformative wave of text-to-image generation models (TTGMs), artists find a powerful ally in their creative endeavors. This study delves into the intricacies of user experiences, seeking to unravel the nuanced tapestry of awareness surrounding artificial intelligence (AI) and TTGMs. Conducted through a comprehensive three-tier quantitative survey involving 79 participants, comprising 31 females and 48 males from diverse backgrounds in India, primarily representing upper-middle-class households, the research endeavor is to capture the essence of users' perceptions. By shedding light on the user's awareness, this study aims to empower TTGM developers with insights to tailor targeted awareness campaigns, fostering a better understanding of TTGMs. Furthermore, gaining profound insights into user experiences lays the groundwork for refining future TTGM models, ensuring continuous enhancement and innovation in this dynamic intersection of art and technology.
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Keywords

Introduction

Artificial Intelligence (AI) is experiencing an unprecedented surge in influence, permeating diverse sectors and redefining the way we live and work. As of 2022, global spending on AI is projected to reach a staggering $110 billion by 2024, underlining the substantial financial commitment to its development [1]. Industries such as healthcare and finance are witnessing transformative shifts, with AI driving advancements in diagnostics, drug discovery, and predictive analytics.The World Economic Forum estimates that AI could create 97 million new jobs by 2025 [2], reflecting its potential to reshape the employment landscape. Despite this, challenges loom, notably in ethical considerations and the need for robust regulatory frameworks.

Organizations are increasingly integrating AI into their operations, with 37% having implemented AI solutions, according to a Gartner survey [3].As we foray into the world of AI, we are governed by different measures of innovations happening in the world of the scientific community. There is a technical surge and billions of terabytes of knowledge base of transacting information in the web sphere happening at lightning fractions of seconds.

The proliferation of AI-related research is evident in the exponential growth of publications, emphasizing the dynamic nature of this field. As AI continues its rapid evolution, addressing ethical concerns, regulatory frameworks, and fostering responsible innovation are paramount to harnessing its transformative potential.

AI art shatters the paradigm of the earliest pictures found on cave walls, human creativity alone has driven art's history. Inspired humans using hand-held tools -- musical instruments or paintbrushes [4].AI's rapid growth in art is propelled by advancements in deep learning, neural networks, and generative algorithms. Techniques like GANs facilitate the creation of autonomous, diverse artworks, showcasing the transformative potential of AI in the artistic domain. AI art is any form of digital art created or enhanced with AI tools. Though commonly associated with visual art -- images and video for instance, - the term AI art also applies to audio compositions, including music.

The earliest iterations of AI art appeared in the late 1960s, with the first notable system appearing in 1973 with the debut of Aaron, developed by Harold Cohen. The Aaron system was an AI assistant that used a symbolic AI approach to help Cohen create black-and-white art drawings[4][5]. AI-generated art began its recent ascent in 2014, when generative adversarial networks (GAN) [6] -- a foundation of generative AI technologies -- were first discussed. In 2015, Google released DeepDream[7], which uses a convolutional neural network (CNN) [8] as an experimental approach to AI art.

The most recent AI model is the text-to-image-generation model. A text-to-image model is a machine learning model which takes an input natural language description and produces an image matching that description [9].These AI tools are trained on huge datasets of pairs of text and images. Such models began to be developed in the mid-2010s, as a result of advances in deep neural networks.

The first modern text-to-image model, alignDRAW, was introduced in 2015 by researchers from the University of Toronto. alignDRAW extended the previously-introduced DRAW architecture (which used a recurrent variational autoencoder with an attention mechanism) to be conditioned on text sequences [10]. Images generated by alignDRAW were blurry and not photorealistic, but the model was able to generalize to objects not represented in the training data, and appropriately handled novel prompts such as "a stop sign is flying in blue skies", showing that it was not merely "memorizing" data from the training set.

Reed, Akata, Yan et al. (2016) became the first to use generative adversarial networks for the text-to-image task [11]. With models trained on narrow, domain-specific datasets, they were able to generate "visually plausible" images of birds and flowers from text captions like "an all black bird with a distinct thick, rounded bill".The public debut of text-to-image GAN-based online services for image generation sparked the imagination and interest of users around the world in January 2021. In 2022, the output of state of the art text-to-image models, such as OpenAI's DALL-E 2, Google Brain's Imagen and StabilityAI's Stable Diffusion began to approach the quality of real photographs and human-drawn art.

The exhibition "Thinking Machines: Art and Design in the Computer Age, 1959–1989" at Museum of Modern Art (MoMA) provided an overview of AI applications for art, architecture, and design. Exhibitions showcasing the usage of AI to produce art include the 2016 Google-sponsored benefit and auction at the Gray Area Foundation in San Francisco, where artists experimented with the DeepDream algorithm and the 2017 exhibition "Unhuman: Art in the Age of AI", which took place in Los Angeles and Frankfurt[12].

In spring 2018, the Association for Computing Machinery dedicated a magazine issue to the subject of computers and art. In June 2018, "Duet for Human and Machine", an art piece permitting viewers to interact with an artificial intelligence, premiered at the Beall Center for Art + Technology[13]. The Austrian Ars Electronica and Museum of Applied Arts, Vienna opened exhibitions on AI in 2019. Ars Electronica's 2019 festival "Out of the box" explored art's role in a sustainable societal transformation. Examples of such augmentation may include enabling expansion of noncommercial niche genres (common examples are cyberpunk derivatives like solarpunk) by amateurs, novel entertainment, novel imaginative childhood play, very fast prototyping, increasing art-making accessibility and artistic output per effort and/or expenses and/or time e.g. via generating drafts, inspirations, draft-refinitions, and image-components (Inpainting)[14].

AI text-to-image generators are continually being improved and some researchers and tech companies are developing the next stage of generative visual art. Meta has released examples of its text-to-video AI currently in development, which can produce a video from a user's text input.Meanwhile, Google has unveiled DreamFusion, a text-to-3D AI [15] that builds upon the technology of text-to-image generators to generate 3D models without the need for datasets containing 3D assets.

Some visual artists have already started incorporating generative AI tools into their workflow and pushing the technology to create animated art. Generative machine learning and its use in 3D art is a promising and exciting technology that can alter how we produce and experience art. This technology also has the potential to make art more accessible to more people[16].

People's perception plays a pivotal role in development of text-to-image generation models. It plays an important role in the models performance, user adaptability and ethical consideration. The understanding of users' perception helps developers make improvements in models. AI Art models that resonate with people's taste are more likely to be accepted by people. Incorporating user feedback allows personalization of AI generated art and helps make AI art models more user friendly. This awareness also guides the design of interfaces and functionalities, contributing to the seamless integration of these models into users' daily lives. Ethical considerations such as privacy concerns etc can also be better approached once the developers are attuned with the user's awareness. Considering people's perception is fundamental for AI generated art to become commercially successful and popular.

In essence, building AI art models with a keen awareness of people's perceptions ensures not only technical excellence but also cultural relevance, ethical integrity, and a positive impact on users and society.In this paper will complement existing work related to text to image generation models and study their impact on the art through an individual's creatives' perception, adoption and use of text to image generation (TTIG) platforms. The main objectives of the study are as follows:

- What are individual's perceptions and attitudes towards text-to-image generation systems and their future?
- How are TTGM systems adopted and used in creative practice now?
- How will TTGM systems change artwork?

Methodology

Research Aim
The aim of this research paper is to understand perception towards Text to Image Generation Models, their effect on art, artisans and other industries. The method of approach used was quantitative method.

Tools Used
A three tiered survey was formulated for the data collection The first section helped in collecting general background information about the respondent. It had three questions: The age, the gender and the country in which the respondent is living.
The second section helps collect information about the user's awareness of AI. It has 4 questions. The first question is a multiple choice question in which the respondent is asked where

he/she thinks AI can be used, the second question is a yes or no question in which the respondent is asked if they think that AI helps in generating images. The third question - 'How aware are you about text-to-image generation platforms' was a linear scale question. The last question was a yes or no question in which the respondent was asked about their awareness regarding Dall-e's outpainting feature.

The third section collects information about the user experience of respondents who have used Text-to-image generation models (TTGM) before. This section contains MCQs such as 'which aspects of the text-to-image output do you find most important?'and ' Which areas of improvement do you think are crucial for future text-to-image AI generators?'. It also contains linear scale questions which ask the user about their satisfaction after using TTGMs and one free response question which asks the respondents what they think the future of TTGMs is.

Sample

79 people responded to this survey out of which 31 were female and 48 were male. All of the respondents belonged to India. 36% of the respondents were above the age of 40, 28% were between the ages of 16-20, 15% were between the ages of 10-15. Most of the respondents belonged to upper middle class families.

Ethical Considerations

All participants provided informed consent for data collection, and their confidentiality and privacy were safeguarded throughout the study. No data would be disclosed in the article or during the research process, adhering to ethical research guidelines.

Data Collection Procedure

The data was collected through an online survey. The various **responses** to each question were converted to graphs to further analyze the data. The aim of this research paper is to understand an individual's perception towards Text to Image Generation Models, their effect on art, artisans and other industries. Respondents were asked about their awareness about AI and TTGMs. They were asked to rate their experience on a scale of 1-5 and about their experience while using TTGMs. Respondents' age group, gender and their familiarity with TTGMs was recorded to understand their perception of such models and what they think about the evolution of TTGMs in the future.

Results and Discussion

This section will be analyzing the survey in which respondents were asked about their awareness regarding TTGMs and their user experience. They were asked to rate their experience on a scale of 1-10 and were given multiple choice questions about the features of TTGMs. The age and background of the respondents was recorded to help understand their perception of such models.
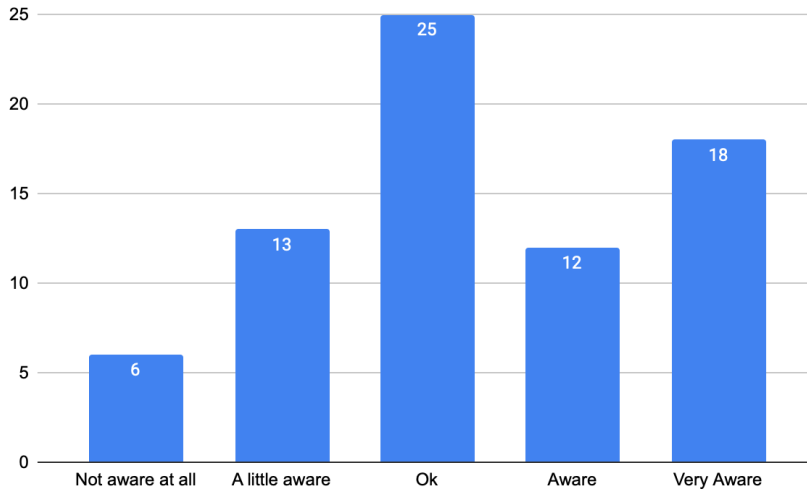
1. **Awareness**

This portion of the results section shows graphs regarding the awareness of the respondents regarding AI, text to image generation models and Dall-e's out painting feature. Understanding the percentage of people who are aware and unaware about AI and TTGMs can help developers make informed decisions and help them design targeted awareness campaigns to spread awareness.
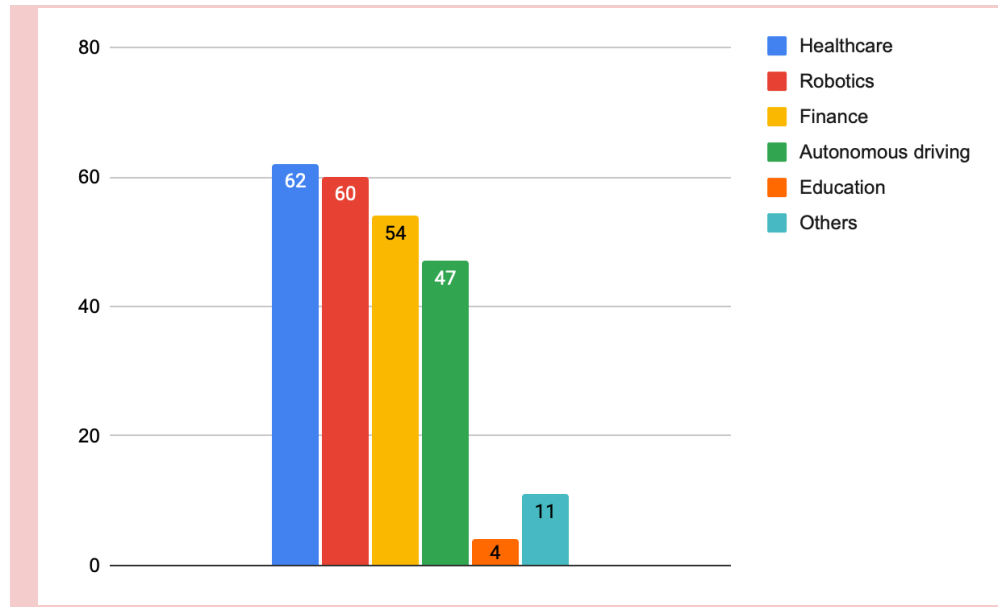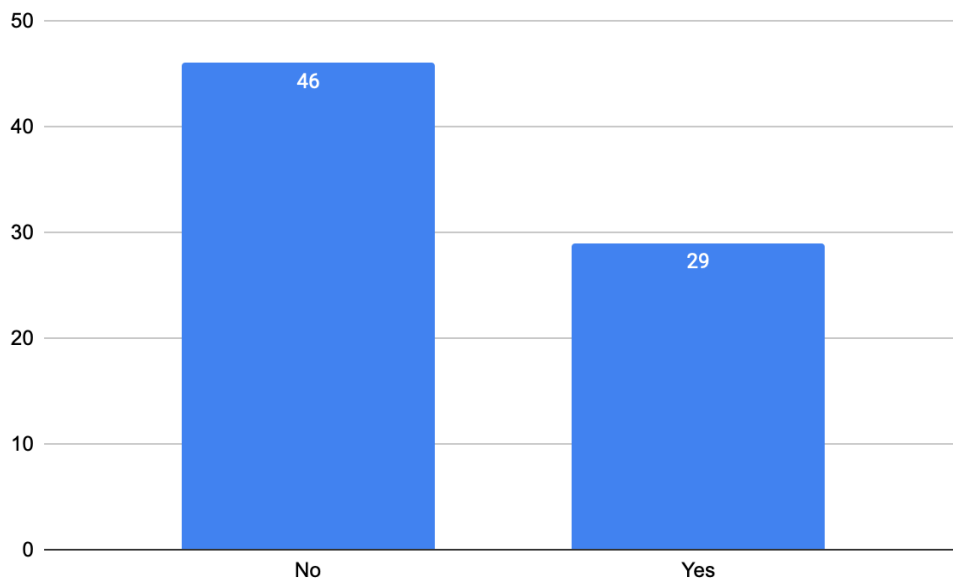

Figure 1: Graphical representation of people's opinion about the usage of artificial intelligence (N=79)

In Figure 1, One can see the perception of people regarding the various uses of AI in daily life. About 82.7% (62) people think it can be used in healthcare, 80% (60) think it can be used in robotics, 72% (56) think it can be used in finance, 62.7% (47) autodrive think it can be used in autonomous driving and about 3.9% (4) and 14.3% (11) think it can be used in education and other related fields respectively.

Figure 2: *Graphical representation of people's awareness about Text To Image Generation platforms (N=79)*

In Figure 2, one can see the awareness of the respondents about text to image generation platforms. 7.7% (6) were not at all aware about text to image generation platforms, 16.7% (13) people were a little aware, 32.1% (25) people were familiar with it, 15.4% (12) people were aware about these platforms and 23.1 % (18) people were properly aware about these platforms.

Figure 3: *Graphical representation of people's awareness about Dall-E's out painting feature (N=79)*

In Figure 3, one can see the respondents awareness about Dall-E's out painting feature. While 61.3% (46) people responded that they are unaware about this feature, 38.7% (29) people responded that they are aware about DALL-E's outpainting feature.
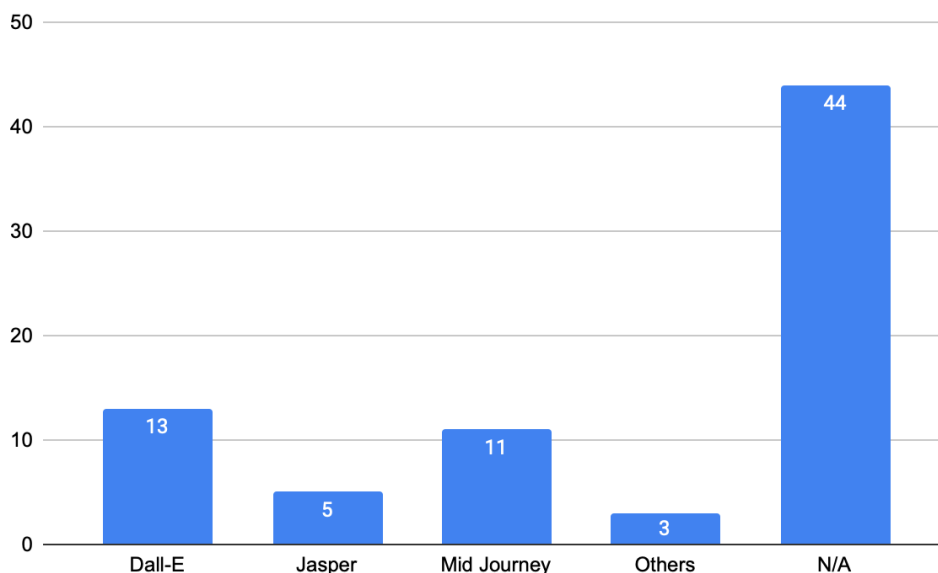
Figure 4: Graphical representation of the number of people who have used different text to image generation platforms (N=79)

In figure 4, one can see how many people have used text - to -image generation platforms and which TTGM is used most and which least. Dall-e is used the most (17.1%) followed by Mid Journey(14.5%) and Jasper(6.6%). Out of all the respondents 57.9% people had never used these platforms before.

2. **User Experience of the AI tool that we used**

This portion of the results section gives the user experience. Understanding the user experience regarding TTGMs will help developers make significant improvements in the upcoming models.
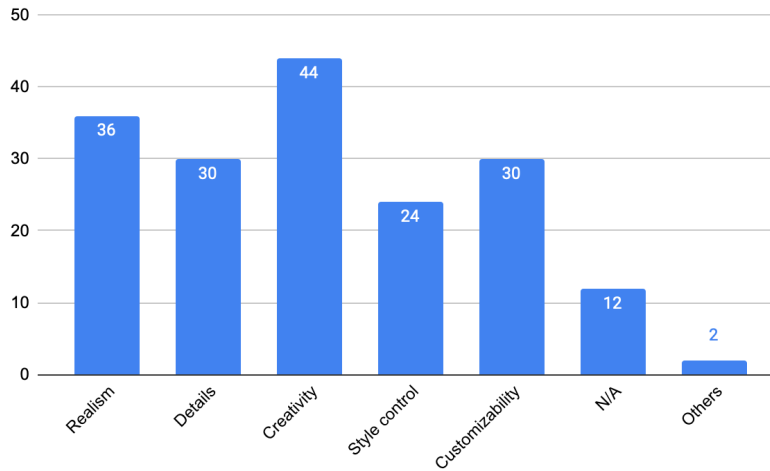
Figure 5: Graphical representation of the different aspects of text to image generation output people find most important. (N=79)

Figure 5, depicts different aspects of users of TTGMs found most useful about TTGMs. Creativity(57.1%) followed by realism(46.8%) is found most important by users whereas style control(31.2) is found least important. Creativity and realism are most important because creativity ensures the generation of imaginative images and realism makes sure that the images generated are according to the pompey entered.
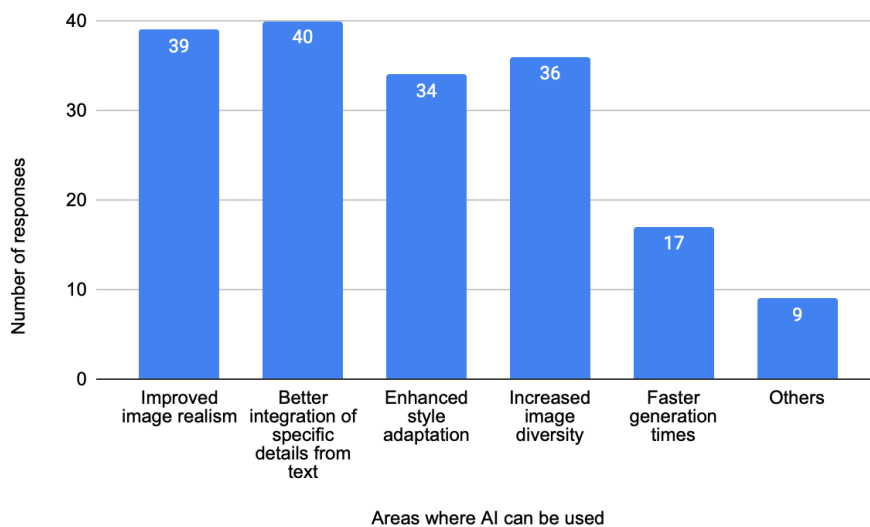
Figure 6: Graphical representation of the areas of improvement people think are crucial for future text-to-image AI generators.(N=79)

In figure 6, one can see the area of improvement users of TTGMs think are important. The feature which needs the most improvement is 'better integration of specific details from text' with 54.1 % of people thinking this area needs improvement. The feature which needs the least improvement is 'faster generation time' with only (23%) people thinking this feature needs improvement.
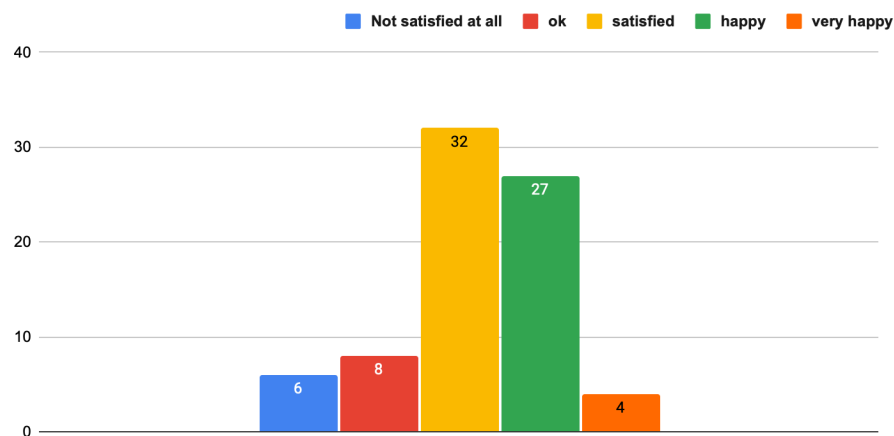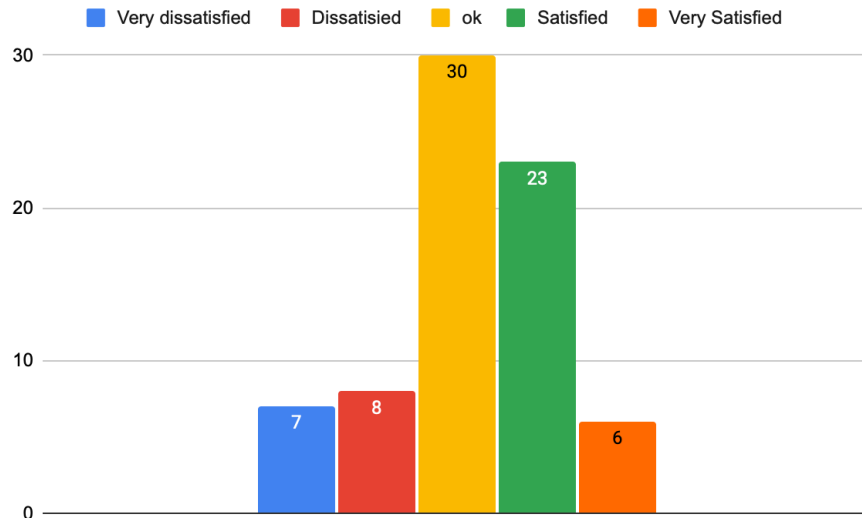

Figure 7: Graphical representation of people's satisfaction with the quality of images generated by text to image generation platforms.(N=79)

In figure 7, one can see the satisfaction rate of TTGM users by the quality of images generated by TTGMs. Only 5.2% people were completely satisfied by the quality of images, 40.3% of people were satisfied by the quality of images and 7.8% people were not satisfied at all by the quality.
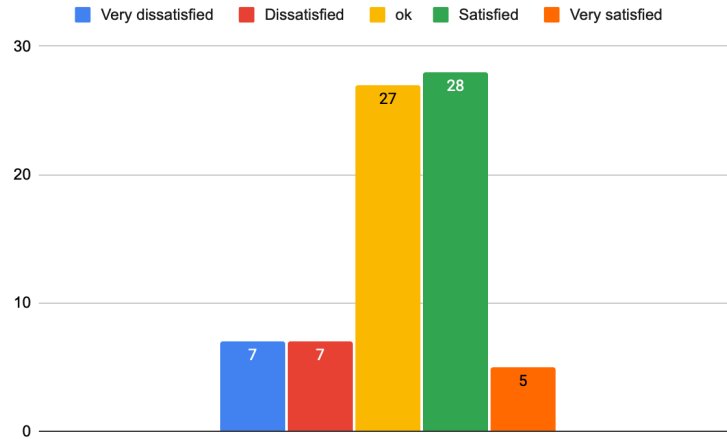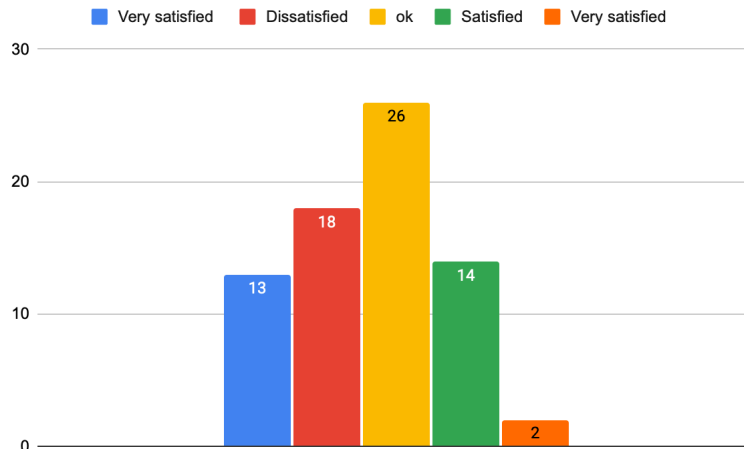
Figure 8: Graphical representation of the number of people who think that the images generated are as per the prompt entered. (N=79)

In Figure 8, one can see the number of people who think that images generated were as per prompt entered. Only 6.8% people think that the images generated were exactly as per prompt entered, 36.5% people think that the images generated were satisfactory and 9.5% people think that images generated were more at all as prompt entered.

Figure 9: Graphical representation of people's overall experience of using text to image generation platforms. (N=79)

In figure 9, one can see the overall experience of TTGM users. 8.1% of users were completely happy with the overall experience of using TTGMs, 40.55 were satisfied with the overall experience and 7.9% were dissatisfied with their experience of using TTGMs.

Figure 10: Graphical representation of people who think images generated by AI are better than hand drawn paintings. (N=79)

In figure 10, we can see the number of people who think that AI generated images are better than hand drawn paintings. Only 2.7% people think that AI generated images are better than hand drawn images, 35.65 people think that AI generated paintings are sometimes better than hand drawn ones and 17.8% people think that AI generated paintings are not at all better than hand drawn paintings.

Discussion

The survey on Text to Image Generation platforms shows the respondents awareness about artificial intelligence and Text to Image Generation platforms. When respondents were asked about the usage of AI in various fields, respondents shared that they think it can be used in healthcare, robotics, finance and 6 autonomous driving. This shows the perception people have of AI being interdisciplinary AI can be used in various fields to improve their output. Iqbal H.Sarker from Swinburne University of Technology, Melbourne 2022 did a study [21] on 'Al based-modeling' and found out that AI techniques can play an important role in developing business, finance, healthcare, agriculture, smart cities, cybersecurity and many more.

Kurt and D.E from Radboud university 2018 also did a study[17] on the artistic creativity in artificial intelligence and how it can be used in generating poetry, music, visuka arts and design.

The majority of respondents (98.7%) have a positive perception of AI's contribution to image generation, with only 1.3% expressing a negative view. Additionally, the data reveals varying levels of awareness regarding Text-to-Image Generation Models (TTGMs), where 7.7% are unaware, 32.1% have moderate awareness, and 23.1% are well-informed. These findings suggest a generally favorable attitude toward AI in image generation and highlight opportunities for targeted education and awareness campaigns to further inform the population about TTGM.

A study done by Harry H.Jiang, Lauren Brown and Jessica Cheng in 2023 also states that the use of AI in art has grown exponentially in the last 2 years.[23] In our survey it was found that Dall-E is the most used TTGM [22]. The people who had used these platforms found features such as creativity, realism, customizability, and details the most important feature about these platforms.

Veera Vimpari, Annakaisa Kultima, Perttu Hamalainen and Christian Guckelsberger in 2023 did a study[18] on professionals' perception, adoption and use of Text-to-image generation (TTIG) systems in games industry practice. They found out that TTGMs have unprecedented output quality and it helps people to generate high-quality visuals. The positive perception of AI's role in image generation aligns with findings from a study on professionals in the games industry. This study indicates that Text-to-Image Generation Models (TTGMs) in the games industry have been recognized for their unprecedented output quality, empowering users to generate high-quality visuals. The overall favorable attitude toward AI in image generation, coupled with professionals acknowledging the superior output quality of TTGMs, suggests a growing acceptance and potential adoption of these systems across various sectors, including the games industry.

Even though TTGMs have a lot of positive characteristics users think that there are still some factors which can be improved such as 'improved realism', 'enhanced style adaptation', ' increase image diversity' and 'faster generation time'.

Many users responded that Text to Image Generation models are a revolutionary tool which will soon be able to perform generation with 100% accuracy and the images generated will soon become indistinguishable from human created images. Eva Cetinic and James She did a review paper in May 2022 [19] regarding use of AI for creative purposes and generating novel art. They found that in the coming years the use of TTGMs to create products will increase by 30% and their accuracy will increase drastically which might affect jobs.

In this paper, it was presented that the study of professional creatives' perception, adoption and use of TTIG systems. Portraying the plurality of views expressed by the participants, it opens up a window to deeper issues underlying the public discussions on the wider adoption of TTIG tools.This research paper provides an overall understanding of the uses of TTGMs and users responses on the use of TTGMs. This will help future researchers make intelligent user interfaces

which will help improve user experience. This research also helps identify the opportunities TTGMs have. To name a few TTGMs could be used in healthcare [20], design industry, movie industry etc. It also helps us understand the features TTGMs have which the users think are unique and helpful. Better understanding of these models can help users use them effectively for personal and professional work. Even Though TTGMs have a lot of advantages they could also cost existing jobs, deny new and extensively trained workforce entry to the industry, yield more but not better games, cause guilt through mandated use of AI against individual ethics, and promote the loss of meaning and agency in artistic work, ultimately impeding well-being on a large scale.

Conclusion

This paper presents a comprehensive study on the creative perception, adoption, and utilization of Text-to-Image Generation Models (TTGMs) among professionals. The study not only illuminates the key features, significant aspects, and potential areas for improvement but also explores the future scope of TTGMs. By leveraging insights from this study, future researchers can enhance TTGMs for an improved user experience.AI text-to-image generators are undergoing continuous refinement, with researchers and tech companies pioneering advancements in generative visual art. Meta has showcased its text-to-video AI in development, capable of generating videos from user text input. Google's DreamFusion, a text-to-3D AI, builds on text-to-image technology to create 3D models sans datasets containing 3D assets. Artists are already integrating generative AI tools into their creative process, pushing boundaries to produce animated art. Generative machine learning, especially in 3D art, holds promise, potentially transforming art production and accessibility, ranging from lifelike 3D models to immersive VR experiences.

In the evolving landscape, the creative sector faces the transformative impact of AI, particularly AI text-to-image generators. Visual artists and creatives observe this technology with a mix of admiration and concern, sparking debates on its role in art and issues like style appropriation.

This paper helps understand people's awareness about TTGMs which can be used for tailoring user education initiatives, ensuring users are well-informed about the capabilities and limitations of the technology. This paper gives information about the advantages of TTGMs and their area of improvement. This knowledge can help developers make improvements in future models of TTGMs which will help improve user experience. It also informs us about how many people from different age groups are aware of TTGMs and how many have used such platforms before. This knowledge can help developers target the right audience to spread awareness about TTGMs and different text - to - image generation platforms.

While this study presents crucial information, it acknowledges limitations, such as a limited dataset affecting generalizability and robustness. Additionally, a more detailed examination of various text-to-image generation platforms, their pros and cons, could enhance the comprehensiveness of future research in this evolving field.

References

[1] Shaqeez, "Worldwide spending on AI is expected to reach $110 billion in 2024," Jan. 22, 2021. https://www.mediabuzz.com.sg/research-analysis-trends-january-2021/worldwide-spending-on-ai-is-expected-to-reach-110-billion-in-2024

[2] Online Bureau, ETHRWorldME, and www.ETHRWorld.com, "IBM: AI will necessitate employees to reskill in the next 3 years," ETHRWorld.com, Aug. 22, 2023. [Online]. Available: https://hrme.economictimes.indiatimes.com/news/industry/ibm-ai-will-necessitate-employees-to-reskill-in-the-next-3-years/102917251

[3] "Gartner survey shows 37 percent of organizations have implemented #AI," Gartner, Jan. 21, 2019. https://www.gartner.com/en/newsroom/press-releases/2019-01-21-gartner-survey-shows-37-percent-of-organizations-have

[4] A. Hertzmann, "Can computers create art?," Arts, vol. 7, no. 2, p. 18, May 2018, doi: 10.3390/arts7020018.

[5] F. A. Poltronieri and M. Hänska, "Technical Images and Visual Art in the Era of Artificial Intelligence": From GOFAI to GANs, Oct. 2019, doi: 10.1145/3359852.3359865.

[6] I. Goodfellow, "Generative adversarial networks," 2014. https://www.semanticscholar.org/paper/Generative-adversarial-networks-Goodfellow-Pouget-Abadie/13bc4e683075bdd6a3f0155241c276a772d4aa06?utm_source=topic_pages_prototype

[7] Wikipedia contributors, "DeepDream," Wikipedia, Dec. 22, 2023. https://en.wikipedia.org/wiki/DeepDream

[8] P. Purwono, "Understanding of Convolutional Neural Network (CNN): a review," 2023. https://www.semanticscholar.org/paper/Understanding-of-Convolutional-Neural-Network-A-Purwono-Ma%E2%80%99arif/020c3cd5ad2a639cc90bb422d43d1d385d1984e7?utm_source=topic_pages_prototype

[9] "Human verification." https://www.semanticscholar.org/paper/Text-to-Image-Translation-using-Generative-Networks-Viswanathan-Mehta/411b974895fcb6640c545f776326d3e0806feaad?utm_source=topic_pages_prototype

[10] E. Mansimov, E. Parisotto, J. Ba, and R. Salakhutdinov, "Generating Images from Captions with Attention," International Conference on Learning Representations, Jan. 2016, [Online]. Available: http://www.thespermwhale.com/jaseweston/ram/papers/paper_13.pdf

[11] S. Reed, Z. Akata, X. Yan, L. Logeswaran, B. Schiele, and H. Lee, "Generative adversarial text to image synthesis," arXiv (Cornell University), May 2016, [Online]. Available: http://export.arxiv.org/pdf/1605.05396

[12] K. Chilson and M. Szabó, "Review of "Thinking Machines: Art and Design in the Computer Age, 1959-1989. Museum of Modern Art.," Journal of Science and Technology of the Arts, vol. 10, no. 1, p. 3, Jun. 2018, doi: 10.7559/citarj.v10i1.497.

[13] Wikipedia contributors, "Artificial intelligence art," Wikipedia, Jan. 10, 2024. https://en.wikipedia.org/wiki/Artificial_intelligence_art

[14] M. Elgan, "How 'synthetic media' will transform business forever," Computerworld, Nov. 01, 2022. https://www.computerworld.com/article/3678172/how-synthetic-media-will-transform-business-forever.html

[15] B. Poole, "DreamFusion: Text-to-3D using 2D Diffusion," 2022. https://www.semanticscholar.org/paper/DreamFusion%3A-Text-to-3D-using-2D-Diffusion-Poole-Jain/4c94d04afa4309ec2f06bdd0fe3781f91461b362?utm_source=topic_pages_prototype

[16] P. Achlioptas, O. Diamanti, I. Mitliagkas, and L. J. Guibas, "Learning representations and generative models for 3D point clouds," International Conference on Machine Learning, pp. 40–49, Jul. 2018, [Online]. Available: http://proceedings.mlr.press/v80/achlioptas18a/achlioptas18a.pdf

[17] D. Kurt, "Artistic Creativity in Artificial Intelligence," Faculteit Der Letteren, Apr. 2018, [Online].

Available: https://theses.ubn.ru.nl/handle/123456789/5631

[18] V. Vimpari, A. Kultima, P. Hämäläinen, and C. Guckelsberger, "'An Adapt-or-Die Type of Situation': Perception, adoption, and use of Text-to-Image-Generation AI by game industry professionals," Proceedings of the ACM on Human-computer Interaction, vol. 7, no. CHI PLAY, pp. 131–164, Sep. 2023, doi: 10.1145/3611025.

[19] E. Cetinić and J. She, "Understanding and Creating Art with AI: Review and Outlook," ACM Transactions on Multimedia Computing, Communications, and Applications, vol. 18, no. 2, pp. 1–22, Feb. 2022, doi: 10.1145/3475799.

[20] S. Agrawal, "Medical text and image Processing: Applications, issues and challenges," 2020. https://www.semanticscholar.org/paper/Medical-Text-and-Image-Processing%3A-Applications%2C-Agrawal-Jain/6121fe086d171c0b0f103be1e9e7892c77ab36b8

[21] Sarker, I.H. (2022) *AI-based modeling: Techniques, applications and research issues towards automation, intelligent and Smart Systems - SN Computer Science*, *SpringerLink*. Available at: https://link.springer.com/article/10.1007/s42979-022-01043-x (Accessed: 20 January 2024).

[22] J. Betker, "Improving Image Generation with Better Captions." https://www.semanticscholar.org/paper/Improving-Image-Generation-with-Better-Captions-Betker-Goh/cfee1826dd4743eab44c6e27a0cc5970effa4d80

[23] Researcher, H.H.J.I. *et al.* (2023) *Ai art and its impact on artists: Proceedings of the 2023 AAAI/ACM Conference on AI, Ethics, and Society*, *ACM Conferences*. Available at: https://dl.acm.org/doi/10.1145/3600211.3604681 (Accessed: 20 January 2024).