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Magnatta et al, 2025: 02 (01)

How Will Our Society Support the Exponential Power Demands of the AI Revolution?

Mattia Magnatta

Abstract: AI, which includes machine learning (ML), deep learning (DL), and generative AI, mimics human-like tasks, behaviors, and intelligence and is altering the way a variety of business sectors operate. As a result, the AI market is booming, and significant investments are being made, including Amazon's investment of over $100B in AI-focused data centers over the next 10 years (CRE Daily, 2024). The growth in AI is significantly driving up data generation and processing, resulting in over three times more power delivery for high-power density AI GPU servers. Silicon CRPS is not able to meet these higher power density requirements at 80 PLUS Titanium efficiency standards. Next-generation GaN and SiC power devices offer superior switching and performance compared to legacy silicon FETS, which enables the continuation of power density and efficiency in CRPS to support the growth of AI in the industry.

1. Introduction

The rapid advancements in artificial intelligence (AI), encompassing machine learning (ML), deep learning (DL), and generative AI, are revolutionizing industries such as manufacturing, healthcare, and automotive. This research explores the pressing question: What strategies can society employ to meet the surging power demands of the AI revolution? Through an analysis of the growing power requirements of data centers driven by AI workloads, this research examines the limitations of current silicon-based power systems and explores innovations in wide bandgap materials such as gallium nitride (GaN) and silicon carbide (SiC). Findings indicate that transitioning to these materials is critical for meeting power density and efficiency standards essential for sustaining AI growth. Implications of these findings highlight the need for industry-wide adoption of advanced power delivery systems to mitigate energy consumption and environmental impact while enabling AI innovation.

Artificial intelligence (AI) enables computers and machines to learn from experience, adapt to new inputs, and perform tasks with human intelligence. AI can be narrowed down into three main categories: machine learning, deep learning, and generative AI.

Machine learning (ML) analyzes data to make predictions or decisions without programming for specific tasks. ML models are trained on existing algorithms to recognize patterns and, based on those patterns, predict future outcomes.

Deep learning (DL) is a subset of machine learning (ML) that uses neural networks, which are programmed to make decisions similar to those of the human brain by weighing options, solving problems, and arriving at conclusions. While ML focuses on predicting outcomes based on statistical algorithms, DL identifies patterns and relationships within data, mimicking human decision-making. This approach is used to recognize objects in images or understand different languages.

Generative AI builds on ML and DL techniques to create new content by learning from existing content. It generates images, text, videos, and other types of material by using patterns learned from previously created human-made data. Based on its training data, it can produce original artwork, compose music, or write text that reflects human creativity.

This research seeks to address the question: How can society on a global scale sustain the growing power demands of AI while minimizing environmental impacts? The AI industry's growth is coupled with exponential increases in data generation and processing, leading to unprecedented demands for power. Addressing these challenges is critical to ensuring that AI's transformative potential can be realized sustainably.

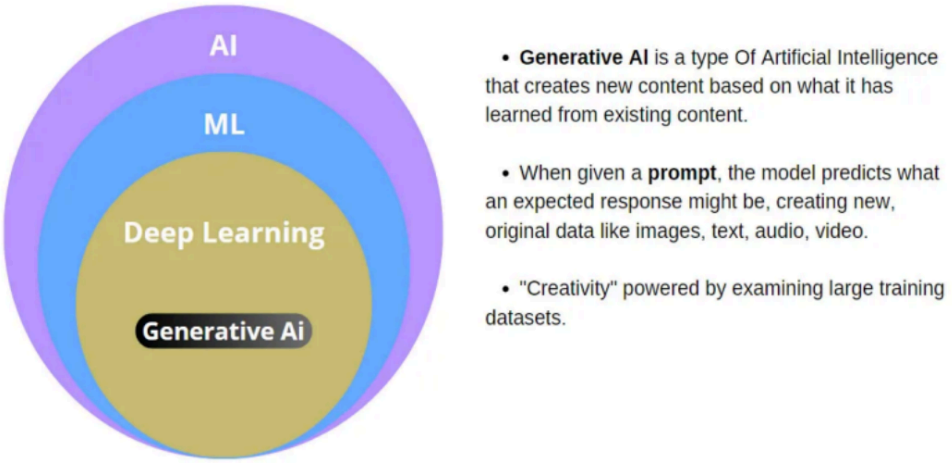

Figure 1: AI comprises Machine Learning (ML) to identify patterns, Deep Learning (DL) that mimics behaviors, and Generative AI, which creates content based on the ML and DL results (Kumar, 2024).

2. Methods

Study Design

This study employs a qualitative and quantitative analysis of AI power demands and technological advancements in power delivery systems.

Procedures

The research analyzed data on power consumption trends in data centers, focusing on AI workloads. Reports from the International Energy Agency, Grid Strategies, and industry white papers were reviewed to understand current and projected energy requirements.

Tools and Materials

Technical specifications for silicon, GaN, and SiC power systems were compared to evaluate performance in terms of efficiency and density.

Participants

No human subjects were involved in this study. Data was obtained from published reports and technical documents.

Data Collection

All subsets of AI will affect markets such as manufacturing, automotive, and healthcare. Autonomous driving systems, for example, use ML to analyze data from a vehicle's surroundings, detect driving patterns, road conditions, and potential dangers, and take appropriate action based on the data. Manufacturing will accelerate into Industry 4.0 with AI programs supporting everything from predictive maintenance to enhanced productivity. At the same time, logistics will be made more efficient using AI techniques to minimize time spent picking, packing, and delivering products from warehouses to customers. In healthcare, while AI may not replace medical professionals, the technology will support accurate, rapid diagnoses that allow them to focus on patient care. Recently, the American Association of Medical Colleges tested the difference between doctor and highly-trained AI diagnoses, noting that:

> "based on data from thousands of images and sometimes boosted with information from a patient's medical record, AI tools can tap into a larger database of knowledge and can scan deeper into an image and pick up on properties and nuances among cells that the human eye cannot detect (Boyle, 2024)."

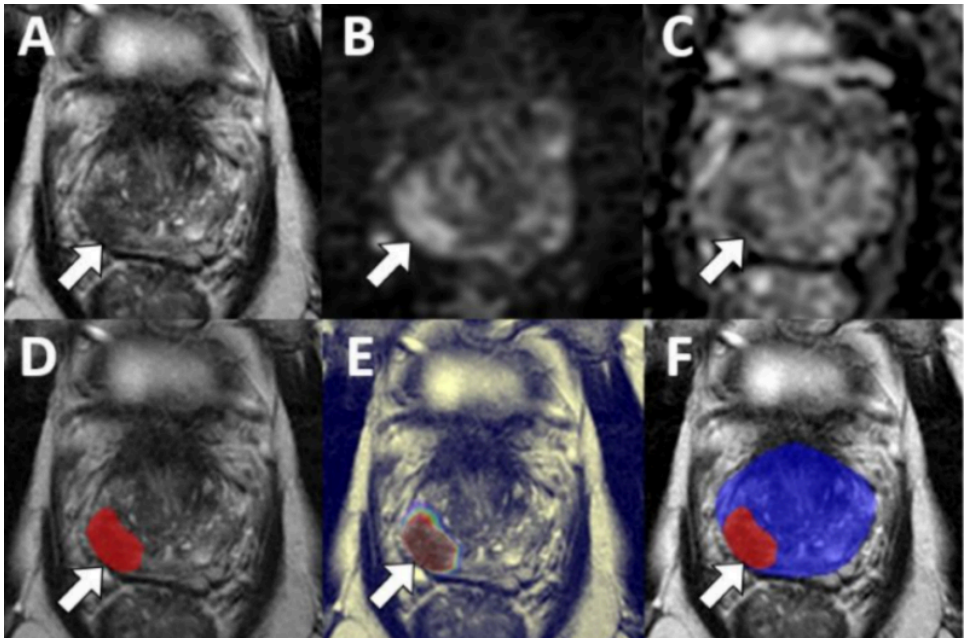

Figure 2: The top row shows how a doctor would identify a tumor from an MRI image. The bottom row shows how AI identifies the tumor and indicates potential affected areas with color coding (Boyle, 2024).

Growth in Data and Data Center Power

In the United States alone, 403 million terabytes of data are created daily (Duarte, 2023). To put this into context, one terabyte is roughly 250,000 professional photos. The need to process, store, and transmit this ever-growing volume of data is beckoning in a new era of data centers and hardware. The fastest-growing demand comes from the need for racks with the capacity to handle the volume of data for AI. This is no surprise given that it took five days for ChatGPT to reach one million users and two months to reach 100 million and that a ChatGPT query uses 10 times more data than a regular Google search (Goldman Sachs, 2024).

This brings with it the significant challenge of meeting demand for power. One query to ChatGPT uses approximately as much electricity as could light one lightbulb for about 20 minutes (NPR, 2024), and Goldman Sachs projects that AI will lead to a 160% increase in data center power usage by 2030. The International Energy Agency (IEA) reports that the exponential growth of AI will see data center energy double by 2027. Gridd Strategies forecasts the power demand due to data use will double in gigawatt consumption based on a 2023 analysis. And it's not just about energy demand – supporting predicted growth will require more power generation and create a rise in data center CO2 emissions, which could more than double between 2022 and 2030 (Goldman Sachs, 2024).

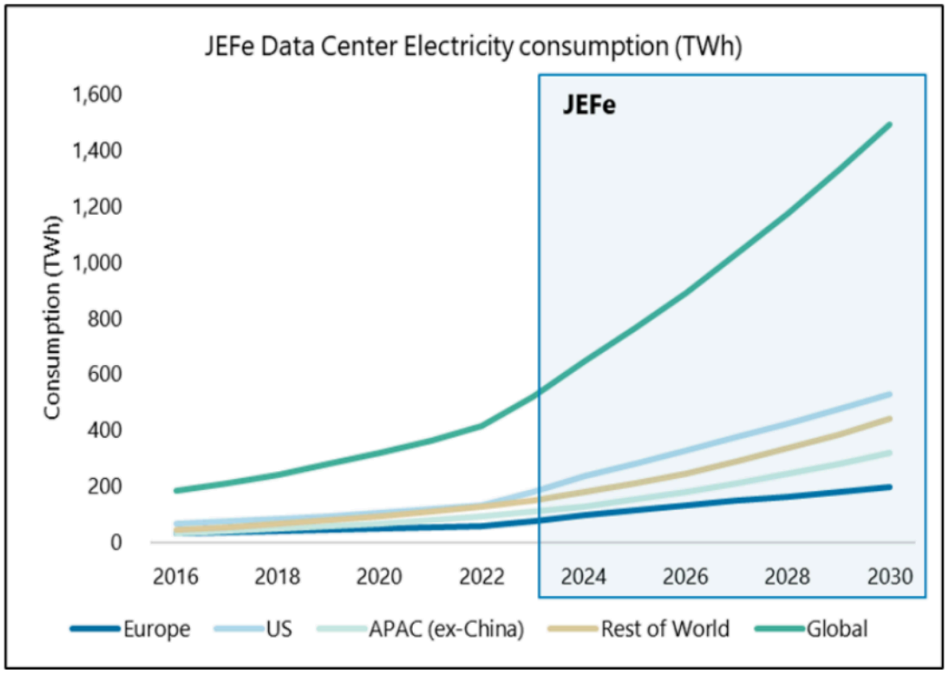

Figure 3: Global Data center electrical power consumption will increase 3x by 2030 due to data processing and AI processing (Jefferies, 2024).

The average data center spans approximately 100,000 square feet, housing around 10,000 servers and consuming 5 MW of power. AI data centers of similar size demand significantly more energy, up to 30 MW, due to the high computational requirements of next-generation GPUs like NVIDIA's Blackwell B100 and B200. These GPUs consume over 1 kW each, three times the power of traditional CPUs. As a result, the power consumption per rack increases from 5-10 kW for non-AI processing to over 60 kW for AI computations. This growing demand has driven power-per-rack specifications from 30-40 kW to as high as 100 kW, highlighting the urgent need for innovations in power delivery systems.

With power-hungry GPUs, power delivery and cooling become critical aspects of these next-generation AI server racks and ensure the scaling of these high-density data centers. Data Center Dynamics reports that 60% of companies are looking to improve their racks to handle the increased heat that comes with more data.

A typical server rack includes essential components such as processors, memory storage, cooling systems, and power supplies designed to ensure continuous operation. The use of redundant power supplies (CRPS) allows server racks to remain functional during power outages or maintenance, providing reliability and minimizing disruptions. Each CRPS is connected to separate circuits to prevent

downtime in case of electrical failures, a crucial feature for businesses that depend heavily on seamless server performance.

The CRPS units are standardized in size to ensure compatibility across different systems, with the Open Compute Project (OCP) leading the way in defining these specifications. Companies like Dell, Meta, Google, Intel, and Microsoft collaborate under the OCP to promote interoperability and streamline upgrades. This collective effort ensures that businesses can easily maintain and improve their server infrastructure, reducing operational interruptions and enhancing overall efficiency.

Figure 4: Two CRPS provide back-up power, ensuring uninterrupted electrical power, in case of a primary power source failure. As GPUs demand more power, the CRPS increases in power density (Kirbtech, 2024).

As GPUs demand significantly more power, CRPS units are required to deliver increased energy while maintaining their compact size. This necessity poses challenges as traditional silicon-based power systems struggle to meet the rising demands. To address these issues, efficiency standards such as the 80 PLUS Titanium certification mandate high energy efficiency, reducing waste and lowering CO2 emissions. Adopted across regions like the European Union, these standards align with broader environmental goals, ensuring that AI data centers operate sustainably while supporting innovation and growth.

	Efficiency					
Load	80 PLUS	Bronze	Silver	Gold	Platinum	Titanium
10%	-	-	-	-	-	90.00%
20%	80.00%	81.00%	85.00%	88.00%	90.00%	94.00%
50%	80.00%	85.00%	89.00%	92.00%	94.00%	96.00%
100%	80.00%	81.00%	85.00%	88.00%	91.00%	91.00%

Figure 5: 80 PLUS Titanium standard requires that PSUs are 90% efficient at 10% of load, 96% at 50%, and 91% at 100% of load with a 230 V input.

Silicon has long been the foundation for power devices in modern power supply units (PSUs). However, next-generation high-power-density PSUs for AI applications are surpassing the material's limitations in power density and efficiency. As a solution, the industry is shifting toward wide bandgap materials like gallium nitride (GaN) and silicon carbide (SiC). These materials excel in meeting escalating power demands due to their ability to switch at higher frequencies and maintain lower resistance, even as temperatures rise. This makes them especially suited for systems requiring greater power efficiency and density. Texas Instruments reports that GaN transistors are 95% more efficient than the old silicon transistors. The transition from silicon to GaN and SiC allows for innovations such as reduced size, weight, and cost of components like inductors and capacitors, paving the way for more efficient and compact power systems.

3. Results

Data Presentation

Findings reveal that AI workloads significantly increase data center power consumption. For instance, a single AI data center with 10,000 servers can require up to 30 MW, compared to 5 MW for non-AI centers. AI GPUs such as NVIDIA's Blackwell models demand over 1 kW per unit, driving power density in racks to unprecedented levels. Silicon-based power systems are increasingly unable to meet these demands while adhering to efficiency standards like 80 PLUS Titanium.

Significant Findings

Wide bandgap materials such as GaN and SiC exhibit superior performance, with higher switching frequencies and efficiency. GaN power systems reduce energy waste and heat, enabling smaller, more efficient designs. SiC's fast switching and excellent conductivity allow for higher power densities and better thermal performance.

4. Discussion/Conclusion

Interpretation

The results indicate that traditional silicon-based power systems are insufficient for the high power density demands of AI workloads. Transitioning to GaN and SiC power systems is not only feasible but necessary for the industry to meet efficiency standards and support AI's growth sustainably.

Implications

How can society fully harness the potential of AI while addressing its electricity demands? This research highlights the critical interplay between technological innovation and power infrastructure. As AI advancements reshape industries that impact daily life, the question of energy sustainability becomes paramount. Although emerging technologies promise to support AI's growth, the effective channeling of electricity is essential. Without strategic power solutions, the continued evolution of AI may face significant limitations. Thus, addressing the energy requirements of AI is not only a technical challenge but a societal imperative.

Adopting GaN and SiC technologies could mitigate the environmental impact of rising AI power demands by reducing energy consumption and CO2 emissions. This transition also supports economic growth by enabling more efficient and cost-effective data center operations.

Limitations

This study is limited by its reliance on secondary data and projections. Future research should involve empirical testing of GaN and SiC systems in real-world AI applications. Additionally, such research must be conducted on a global scale, which presents challenges due to the wide scope of collaboration required. However, this global approach is both important and necessary, as AI is inherently a worldwide conversation and issue.

Solution

As AI demands increase, the focus shifts to finding effective power solutions that balance efficiency and sustainability. Technologies like GaN and SiC offer promising advancements due to their ability to reduce energy waste and operating temperatures, enabling compact designs with fewer cooling requirements. However, they are not the only paths forward. Other energy solutions, such as hydroelectric and nuclear power, are also being explored for their potential to provide large-scale, reliable energy to meet the growing needs of AI data centers. This diverse approach to energy innovation reflects the necessity of combining cutting-edge materials with sustainable energy sources to address the challenges of powering AI workloads.

Conclusion

To sustain AI's transformative potential, the industry must embrace advanced power delivery systems and consider diverse energy sources. These innovations are essential for ensuring AI's

growth aligns with environmental sustainability. On a global scale, this requires collaborative efforts across nations to develop unified standards for energy efficiency and sustainability, especially in their business practices. International partnerships can enable the sharing of advanced technologies and operations, ensuring equitable access to AI advancements. This global approach is vital to addressing the widespread energy challenges posed by the rapid growth of AI-driven industries

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Orange County Water Resilience: A Comparative Study of Desalination and Wastewater Management

Jonathan Shi

Abstract: The persistent effects of population growth, climate change, and diminishing freshwater sources have made water scarcity a critical issue worldwide. In California, sustained droughts have overtaxed the water sources crucial to its economic, social, and agricultural infrastructure. This, in turn, has increased the need for sustainable water resources, and the ongoing depletion of vital groundwater resources has left the state over-reliant on interstate imports and unsustainable in the long term. However, two methods have emerged that could potentially replenish California's depleting water sources: reverse osmosis (RO) desalination and wastewater management. Exploring the history, development, and efficiency of these methods, this paper aims to gauge and compare the effectiveness of these two water extraction systems. By evaluating each method's energy efficiency, cost, sustainability, and political feasibility, we aim to determine the best option for both Orange County specifically and California generally moving forward. While RO desalination can provide high volumes of freshwater, it has drawbacks, including extreme energy costs and the potential destruction of marine environments. Wastewater management, on the other hand, provides more energy-efficient, cost-effective, and environmentally sustainable freshwater. However, it faces significant backlash from public skepticism around initiatives like the "toilet to tap" campaign. This paper concludes that a hybrid approach featuring both methods contingent on environmental and infrastructural conditions would best address California's water concerns, but it also argues for the clear prioritization of wastewater management over RO desalination in the most feasible cases.

1. Introduction

Water is essential to the sustainability of life, ecosystems, and development. Industries in every sector of the modern economy rely heavily on the presence of bodies of water to sustain their goods, services, and supply chains, proving essential to the functioning of our modern economy (Gleick, 2003). However, access to

water per capita has gradually diminished over time, a phenomenon caused largely by decreased death rates and diminishing access to bodies of freshwater for various populations worldwide (Postel, 2000). The greatest freshwater source, glaciers, is also rapidly declining due to climate change, contributing to rising sea levels and reduced freshwater availability (Huss & Hock, 2018). Compounding these already dire conditions, the frequency of severe weather events is expected to increase commensurate with expected changes in global temperatures (IPCC, 2021). California, where roughly a third of the nation's fruits and three-fourths of the nation's fruits and nuts are grown (CDFA, 2022), hosts a Mediterranean climate characterized by variable weather patterns, leaving it particularly susceptible to drought. Despite the rare but significant precipitation that the state experienced in 2023, pervasive water challenges still remain, as the recent precipitation is nowhere near enough to restore the state's depleted groundwater basins, which account for 40% of the state's water supply (Hanak et al., 2019).

With state leadership recognizing the crisis, measures have been taken to preserve the dwindling water supply. For instance, the recent Executive Order N-4-23 suspended flood diversion regulations to allow for floodwater capture, but this by itself will not resolve the issue of scarcity (Governor's Office of California, 2023). Given the unreliability of annual snowpacks and the looming threat of drought, floodwater capture may prove entirely inoperative (Mann & Gleick, 2015). In the long term, CA officials and other concerned parties have turned primarily to two potential solutions: desalination and wastewater management (Hanak et al., 2019).

By surveying the available literature, this paper assesses the efficiency, viability, sustainability, and longevity of each strategy in order to make an evidentiary recommendation for CA policymakers to pursue. Based on current data, wastewater management is overall the more efficient option when factoring in both acre-feet per input yields and environmental sustainability, but RO desalination, especially if combined with sustainable hybrid energy sources, could also be a viable option in cases where little to no water infrastructure is available (Cooley et al., 2019).

2. Methods

Study Design

The study utilizes a comparative policy analysis to evaluate RO desalination and wastewater management. The analysis focuses on assessing the efficiency of the two methods in addressing California's water scarcity issue. Comparisons were made based on four criteria: yield, cost, sustainability, and political feasibility.

Procedure

The study follows a systematic approach to compare the two potential solutions to address Orange County's water scarcity. First, the relevant case studies, different public documents and reports related to global and Californian performance and effectiveness of the two

methods were examined. Then, the criteria to rate the methods were tailored based on energy requirements, costs of operation, sustainability, and political viability From various sources data were compiled and deduced to make correlations and comparisons. Policy documents and news articles related to public perception were studied to gauge the political viability of the methods whereas the technical parameters and the economic aspects were scrutinized to evaluate the adequacies and inadequacies of each of the methods in different circumstances. Finally, the results were synthesized to prepare a comparison of the methods and provide the guidelines that may help solve the problem of water shortage in California.

Data Collection

Data for this analysis were sourced from a variety of academic journals, government reports, and case studies on water management in California. These sources provided a comprehensive view of the operational performance of both desalination and wastewater management, including their environmental effects, financial implications, and political considerations. Policy documents and feasibility studies also helped understand the broader legislative and regulatory landscape impacting each water management method. This diverse set of data points allowed for a nuanced comparison of the two methods, focusing on their real-world application and long-term viability.

Tools and Materials

Statistical programs like SPSS and Excel were employed in the analysis of numerical data pertaining to costs, energy consumption, and environmental issues. Such tools motivated the estimation and evaluation of important benchmarks for reverse osmosis desalination and wastewater management. They used Microsoft Excel's charting features to create bar and pie charts in order to graphically present the data. These visual tools aided in elucidating the differences between the two approaches in energy efficiency, operational costs, and environmental impact, and thus helped in easier understanding and communication of the comparative figures.

3. Results

Overview and History of Reverse Osmosis Desalination

Desalination is a process that converts saltwater to freshwater by separating the saline content from sourced saltwater through various methods (National Academies of Sciences, Engineering, and Medicine, 2008).

Dry landscapes that have to sustain a significant population, such as Spain and Israel, resort to reverse osmosis (RO) technology in their desalination plants to take advantage of their coastal environments (Fritzmann et al., 2007). Reverse osmosis occurs by using a large amount of pressure to force saltwater through a semipermeable membrane through which salt particles cannot pass: the water or solvent transferred

through the membrane becomes purified freshwater (Miller, 2003).

In practice, such as at the Carlsbad plant in California, RO desalination follows a fairly standardized process. First, seawater is collected through large pumps. In these pumps, screens filter out fish, seaweed, and other debris. Then, this water undergoes pre-treatment to remove impurities that could damage the membranes (San Diego County Water Authority, 2016). After treatment, high-pressure pumps move the water toward and through the membranes, which separate the salt from the water. The freshwater is then collected from the tank while the brine waste is pumped out into the ocean (Cooley & Donnelly, 2019). Next, the freshwater undergoes post-treatment, in which minerals or other additives are added in order to meet health standards (Cooley & Donnelly, 2019). Finally, the treated freshwater is pumped into local water supplies (San Diego County Water Authority, 2016).

The prospect of using osmosis to remove salt from seawater was first experimented with at UCLA in 1949, with the intent of achieving the Kennedy administration's goal of discovering solutions to the water shortages plaguing the country (Seidel et al., 2001). However, membranes were ineffective due to their high flux, or flow rates, which risked the leakage of contaminants into the purified solution, and the efforts were largely abandoned in the 1950s in favor of electrodialysis and thermal desalination (Miller, 2003). In the 1960s, the process of reverse osmosis was invented by researchers at UCLA who developed the first reverse osmosis membranes, allowing water to pass through the membrane instead of the salt (as it does in regular osmosis) (Seidel et al., 2001), and the federal government soon invested in small-scale plants in California, Texas, and Florida. Due to the extreme energy cost of the process and the prohibitive manufacturing cost of the membranes, all of these plants failed (Seidel et al., 2001).

It wasn’t until the 1990s that breakthroughs in membrane technology and energy recovery systems mitigated the operational costs enough to allow for the proliferation of RO desalination throughout the U.S., the Middle East, Northern Africa, and Australia (Ghaffour et al., 2013). With federal backing in the U.S. secured courtesy of the Water Desalination Act of 1996, large-scale plants were developed in coastal regions nationwide (U.S. Department of the Interior, 1996). Coastal states like California and Florida began seriously exploring desalination as a sustainable solution to meet their growing water demand (Cooley & Donnelly, 2019).

In 2015, the Claude "Bud" Lewis Carlsbad Desalination Plant, located near San Diego, became the largest desalination plant in the Western Hemisphere. The plant provides about 50 million gallons of fresh water per day, supplying around 10% of the region’s water needs (San Diego County Water Authority, 2016). The Carlsbad plant exemplifies California's approach to using RO desalination as part of a larger water management strategy, which also includes

conservation, recycling, and water imports (Cooley & Donnelly, 2019).

However, California's experience with desalination has not been without challenges. The energy-intensive nature of the process and concerns about environmental impacts, such as the disposal of brine into the ocean and the potential ramifications for marine life, have sparked debate (Lattemann & Höpner, 2008). Environmental groups have also raised concerns about the costs of desalinated water, which tend to be higher than other water sources, leading to questions about the long-term sustainability of desalination as a primary water source (Cooley & Donnelly, 2019).

Overview and History of Wastewater Management

Wastewater management collects various forms of wastewater, including wastewater generated by households, agriculture, and manufacturing facilities, and purifies them, making them safe for reuse or release back into the environment (Ghaffour et al., 2013). Especially in arid regions, wastewater recycling has proved critical to maintaining dwindling freshwater supplies (Wang et al., 2017).

Unlike the relatively modern practice of desalination, wastewater management has a history that dates back to ancient civilizations. The Romans and Indus Valley civilizations developed crude sewage systems, but the modern incarnations of the practice began in the 19th century, most of which were spurred on by public concerns over outbreaks of waterborne diseases like typhoid and cholera (Baker, 2005). In turn, cities across the globe developed structured sewage systems; the first sewage plan was constructed in London in 1865 and relied on a rudimentary form of filtration (Gandy, 2004).

The first major breakthrough in the practice was the development of activated sludge in the 1920s, a process that relies on bacteria to break down the organic matter in wastewater (Metcalf & Eddy, 2014). Various forms of it still see widespread use today (Mara, 2004).

With the notable exception of the 1948 Truman-era Federal Water Pollution Act, wastewater management procedures went largely unregulated throughout the first half of the twentieth century. However, public outcry over the polluted Cuyahoga River catching fire prompted the passage of the 1972 Clean Water Act, which set comprehensive release standards, revolutionized wastewater management processes across the U.S., and set aside significant federal funds to invest in wastewater management infrastructure (Hoffman, 2010).

In the 1980s and 1990s, federal investments prompted the development and proliferation of tertiary treatment processes, which use various forms of filtration including chlorination, UV disinfection, and even reverse osmosis, to further purify wastewater sources (Asano et al., 2007). The substantial increase in effectiveness of these new methods, which were able to remove nutrients like nitrogen and phosphorus as

well as trace metals from water sources, brought wastewater recycling into the international spotlight as municipalities in arid regions around the world, from the Middle East and Australia to California, invested heavily in the new technology (Ghaffour et al., 2013).

California has also led the way in wastewater treatment. The 2008 Groundwater Replenishment System (GWRS) is one of the most cost-effective yielding and cleanest such schemes to date (California State Water Resources Control Board, 2020). A hybrid system that couples microfiltration technology with UV disinfection and reverse osmosis is implemented, under the GWRS, as the final stage of sewage treatment in conjunction with percolation facility infiltration for reuse within the community (California State Water Resources Control Board, 2020).

Despite its ecological benefits, wastewater recycling is often maligned by the public due to psychological fears of contamination, its perceived energy inefficiency, and the process's treatment costs (Patterson et al., 2016). Nevertheless, the increasing urgency of water scarcity, technological advancements, and comprehensive public awareness programs have made wastewater recycling more attractive in recent years (Baker et al., 2016).

Comparison

Yield/ Energy Efficiency

RO desalination guarantees adequate freshwater production, and coastal areas are almost always understood to be having a reliable saltwater feed. For example, the Carlsbad Desalination Plant in California produces about 50 million gallons of freshwater a day, which is around 10 percent of the water required in that region (California Coastal Commission, 2015). If the former seems good, one must remember that this process is very energy intensive; it takes more energy to transfer merged water through a porous membrane, making them quite expensive to the market posteriorly (Davenport & Wang, 2022).

On the other hand, sewage treatment, such as the GWRS in California, has proved to be much more energy efficient. GWRS produces about 100 million gallons of fresh water daily, becoming approximately one and a half times larger than Carlsbad (California State Water Resources Control Board, 2020). Freshwater production is comparable in both technologies; however, wastewater recycling is the more energy-competitive technology with respect to existing infrastructure use and energy consumption (Ghaffour et al., 2013).

Cost (Maintenance)

Desalination via RO involves much more in terms of initial capital investment and continuing operating and maintenance costs. A complication with RO systems, involving high-pressure systems (and semi-permeable membranes requiring near-continuous replacement), means compounded operational and maintenance costs. For example, the operational cost of the Carlsbad Plant is approximately $2,000 per acre-foot. On the other hand,

conventional costs for alternative water resources range between $300 and $1,000 for the same volume(Gleick et al., 2015).

In contrast, reclaimed water does provide an economically viable option. Rather than concentrating on the extraction of a saline component, the microfiltration approach eliminates suspended particulates, most notably with ultraviolet disinfection to target disease-causing microorganisms in wastewater. The GWRS, located in Orange County, produces water with a reasonable cost of $850-1,100 per acre-foot, making it one of the more affordable alternatives (California State Water Resources Control Board, 2020). In addition, wastewater recycling systems are not as laborious in the way of ongoing maintenance. Advancements leading to stability improvements over time make them less fussy with fouling mechanisms than desalination systems (Ghaffour et al., 2013).

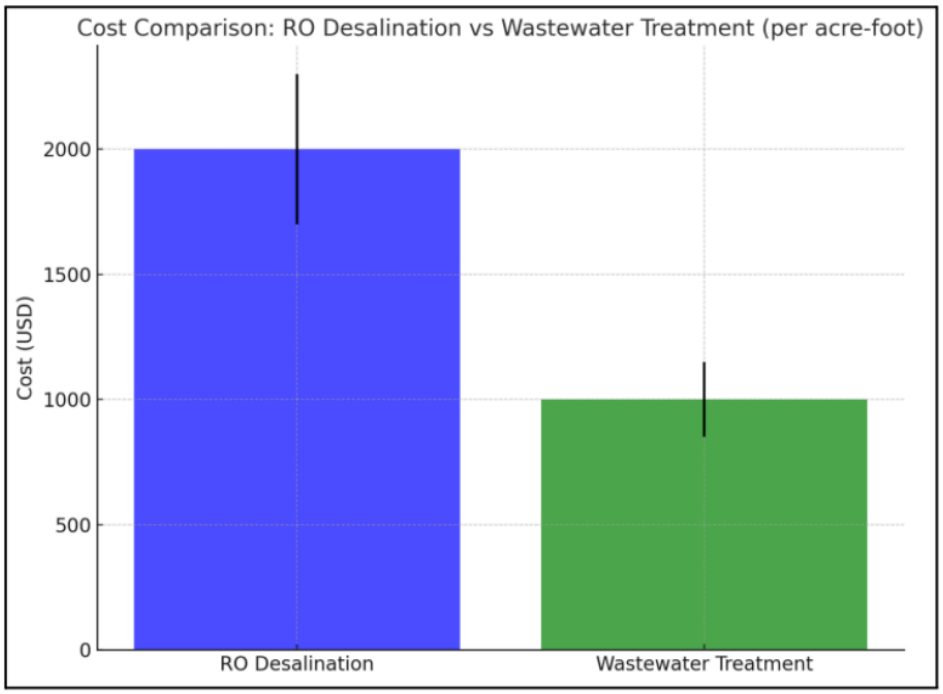

Figure 1: Bar graph comparison of treatment cost per acre-foot of raw water. Cost of RO desalination estimates around $2,000 while wastewater treatment is half as costly.

Sustainability

By nearly all metrics, wastewater recycling is more environmentally friendly than RO desalination. This advantage arises primarily from the fact that wastewater recycling draws from and replenishes existing water supplies, minimizing ecological damage, while RO desalination converts its water supply entirely from

non-potable saline sources. Such systems as GWRS offer not only a reliable water source, but also assistance in recharging groundwater levels, which are an essential resource within drought-stricken areas such as California (California State Water Resources Control Board, 2020).

Wastewater recycling produces fewer byproducts than desalination, which generates substantial amounts of brine. This highly concentrated salt byproduct is frequently pumped back into the ocean. The high salt content of brine can severely disrupt the chemical balance of seawater and adversely impact marine organisms (U.S. Department of the Interior, 2017).

Still, reverse osmosis desalination is among the most carbon-intensive per cubic meter of produced water due to poor energy efficiency of the desalination process itself. The efficiency of seawater reverse osmosis has been greatly boosted with the advent of modern membrane technology and the optimal energy recovery systems, but overall energy consumption and the associated carbon emissions are still far greater than for recycled wastewater. Fresher brine disposal into the ocean is another major drawback of seawater reverse osmosis (Ghaffour et al., 2013). For this reason, in most cases, wastewater recycling is a sustainable solution for water management.

Metrics	Wastewater Recycling	Reverse Osmosis Desalination
Brine Production	Minimal (approximately 10-20% of inflow)	40-50% of inflow (high concentration)
Environmental Impact of Byproducts	Low (beneficial for water systems)	High (affects marine ecosystems)
Carbon Emissions (g CO_2/m^3)	50-70 g CO_2/m^3 (estimated)	700-1,200 g CO_2/m^3 (depends on energy source)
Energy Consumption (kWh/m^3)	0.5 - 1.0 kWh/m^3	3.5 - 5.0 kWh/m^3
Water Quality	High-quality potable water possible	High-quality potable water
Sustainability	Highly sustainable	Less sustainable due to ecological impact

Political Feasibility

RO desalination enjoys political support from select technology and energy companies that view the process as more profitable than wastewater recycling. In particular, technology companies in Silicon Valley regard RO desalination as an exciting entrepreneurial opportunity. The company that patents technology to make the process more energy-efficient or commercially viable stands to gain billions in revenue from private and public contracts (Gleick, 2018). Additionally, energy companies benefit from the steady demand generated by desalination plants, which bolsters energy prices in the market. Together, these groups create a formidable lobbying force for desalination advocates, making the process especially attractive to large banks, investment firms, venture capitalists, and other financial interests (Perry et al., 2019).

Conversely, RO desalination tends to be supported predominantly by wealthy communities that can absorb or offset the high costs of the process. Given that RO desalination is often cost-prohibitive without significant public subsidies, it is generally limited to affluent coastal communities, such as Carlsbad and Huntington Beach in California (Baker et al., 2020). Moreover, RO desalination is considered essential in arid regions lacking readily convertible or accessible wastewater infrastructure, such as Spain, Saudi Arabia, the UAE, and Israel; however, the success of desalination efforts in these areas varies significantly (Salameh & Yousef, 2018).

Nonetheless, support for RO desalination is far from unanimous. Concerns about its environmental impact—particularly brine disposal—along with significantly higher costs and high energy consumption have led to persistent resistance from environmental groups, local community leaders, and some policymakers (Zhou et al., 2020). Furthermore, worries about access gaps created by RO desalination, which can only be funded by affluent communities or politically charged public subsidies, have led critics and researchers to conclude that the adoption of the process could exacerbate regional, socioeconomic, and racial inequalities (Patel & Koggel, 2019).

Despite its efficiency, cost-effectiveness, and sustainability, public reaction against wastewater management has been well-documented for decades. This skepticism was notably exemplified by the failure of the 2000 Toilet to Tap campaign launched in Los Angeles due to widespread concerns over water quality. Shortly after its public announcement, the campaign faced significant opposition from local leaders, politicians, and the media, leading to its cancellation (Thompson et al., 2019). While public perception of wastewater recycling has improved, especially in light of pressing water scarcity issues, distrust in the process remains a significant barrier to its adoption. Water experts now recommend pairing wastewater recycling initiatives with broader awareness and education campaigns, which can increase costs and extend implementation timelines (Zhao et al., 2021).

In Orange County specifically, wastewater recycling has proven politically feasible and widely supported, largely due to the success of the Groundwater Replenishment System (GWRS). The GWRS is often cited as a model for innovative water management and has received significant backing from both local and state governments. Its ability to provide a reliable water supply in a drought-prone region, coupled with its low environmental impact and cost-effectiveness compared to RO desalination, has made it politically favorable, helping to overcome the persistent "toilet-to-tap" stigma (California Department of Water Resources, 2018).

4. Final Recommendations and Conclusion

To effectively address water scarcity, Orange County should adopt a balanced approach that combines both wastewater recycling and desalination. However, there should be a greater emphasis on expanding wastewater recycling efforts due to its economic and environmental benefits. Expanding wastewater recycling is essential, as the Groundwater Replenishment System (GWRS) serves as a successful model for sustainable water management (California Department of Water Resources, 2018). Increasing investment in advanced wastewater recycling facilities will reduce reliance on imported water and ensure a sustainable water supply. Furthermore, it is necessary to implement public outreach programs to alleviate lingering concerns about the safety of recycled water, thereby gaining broader community acceptance and support (Zhao et al., 2021).

While wastewater recycling should take precedence, improving desalination technology can serve as a valuable complement to these efforts. Desalination offers an opportunity to diversify water sources, particularly in areas with abundant seawater and limited existing water infrastructure. However, technological advancements are needed to reduce energy consumption and minimize environmental impacts, such as those caused by brine disposal (Zhou et al., 2020). Orange County could benefit from supporting pilot programs aimed at enhancing the efficiency and sustainability of desalination processes. Additionally, pursuing federal or state funding to develop better energy recovery systems and eco-friendly brine management methods would be beneficial (Perry et al., 2019).

An integrated water management strategy is vital for creating a resilient and diverse water portfolio in Orange County. This strategy should encompass a combination of conservation, stormwater capture, groundwater replenishment, wastewater recycling, and, when necessary, desalination (Gleick, 2018). Encouraging policies that prioritize water reuse and conservation, while maintaining minimal reliance on desalination, will help balance long-term sustainability with immediate water needs, ultimately resulting in a more robust water system.

Lastly, legislative and financial support from both federal and state governments should continue to play a crucial role in facilitating wastewater recycling projects. By providing grants, tax

incentives, and low-interest loans, government authorities can make water reuse and advanced treatment technologies more affordable and politically viable across California, including Orange County (Thompson et al., 2019). This ongoing support will not only foster innovation but also ensure that sustainable water management practices can effectively meet the challenges posed by water scarcity.

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Chinese Americans Take Center Stage: Interwar Film Representation and the Repeal of the Chinese Exclusion Act

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Abstract: The American interwar period saw the emergence of a Chinese American identity. The nature of American film as a reflection of social dynamics provides an opportunity for in-depth analysis of its representation of Chinese Americans. Adhering to the Motion Picture Production Code, many filmmakers and actors were initially limited in expanding beyond stereotypes. This paper examines the films leading up to the repeal of the Chinese Exclusion Act and how they mirror the progression of societal acceptance towards Chinese Americans through their increasing degrees of meaningful representation. Through an analysis of key films such as *The Mysterious Dr. Fu Manchu* (1929), *Daughter of the Dragon* (1931), *Charlie Chan at the Opera* (1936), and *Daughter of Shanghai* (1937), the study reveals how these racialized portrayals allowed public perception of Chinese immigration policy to shift in favor of expansion rather than restriction. From portraying Orientalist stereotypes such as the "Dragon Lady" or "Yellow Peril" to recognizing Chinese Americans as truly American, films from 1929 to 1937 had evolved alongside changing social attitudes and ultimately legislation. By connecting film representation to legal and cultural analysis, this paper attempts to highlight the nuanced relationship between popular media and social changes in perception of Chinese Americans as accepted within American society.

Introduction

In the wake of the 1882 Chinese Exclusion Act, Chinese American grassroots organizations played a pivotal role in reshaping community identity. Organizations such as the Chinese Unemployed Council, the Chinese Hand Laundry Alliance, and the Chinese American Restaurant Association of Greater New York divested control of community identity away from the Chinese American elite and to the working and middle class. Further, the Chinese Americans of the 1930s, who felt more American than Chinese, paved the way for increased

visibility of the Chinese American identity (Song, 386-76). However, while the impact of these labor movements is evident in records of their parades, rallies, and their recorded involvement in the 1932 and 1936 presidential campaigns, the era still contains relatively few primary sources from individual Chinese Americans due to perceived unimportance and linguistic barriers (Bankston, 498-499). Thus, film and media representation are some of the only records during this time period that can offer insight into how Chinese Americans were perceived socially and culturally.

Hollywood films of the 1930s provide a lens to examine both the nation and its culture. These films and their content offer a lens into pervasive American concerns. Films "present themselves to the historian for dual service: they are both historical documents and interpretive histories" (Sobchack 294). As such, the interplay of Chinese and Chinese American representations and Hollywood's feature films from the 1930s to the 1940s can help in the understanding of the Chinese American identity during Hollywood's Golden Age, and analyzing The Mysterious Dr. Fu Manchu (1929), Daughter of the Dragon (1931), Charlie Chan at the Opera (1936), and Daughter of Shanghai (1937) can reveal shifts in public perceptions of Chinese Americans. A critical analysis of these films shows how the portrayals of Chinese characters, although influenced by prevailing racial ideologies, reflected the Chinese American community's fight for visibility and acceptance. Therefore, by analyzing classic Hollywood films produced during the interwar period, we can better understand the complexities of racial integration and the role of media in shaping and reflecting societal attitudes towards Chinese Americans during this pivotal era, especially for second generation Chinese American women.

Attitudes Towards Chinese Americans Reflected Through Law

Although Chinese immigration to the United States had been encouraged by demands for railroad laborers, the completion of the transcontinental railroad in 1869 brought with it strong sentiments against working-class Chinese Americans (Pegler-Gordon 51; Marcus and Chen 369; Carson 89). These negative feelings led to the passage of the Chinese Exclusion Act of 1882, the first exclusionary immigration legislation to bar entry on the basis of race (Marcus and Chen 369-70). Specifically targeting Chinese laborers, who were deemed undesirable due to racial prejudices and fears of labor competition, the Act prohibited their entry into the United States. Importantly, the Act exempted Chinese merchants, diplomats, and students, reflecting a discriminatory policy that distinguished between the Chinese elite and the working class (Marcus and Chen 369-70).

The legal landscape further complicated the identity formation and societal integration of Chinese Americans, illustrated by the landmark cases of Chae Chan Ping vs. United States (1882) and Wong Kim Ark vs. United States (1898). In both cases, legislation was modified based on race and upheld the controversial plenary

power doctrine—Congress' full control over immigration legislation. In primarily restricting immigration legislation to Congress, changes to immigration law became defined by upholding national security, which oftentimes meant the exclusion of those considered dangerous to the sanctity of American society. These cases exposed the racially motivated and subjective nature of American immigration law, which often viewed Chinese individuals, whether China-born or domestic-born, as perpetual foreigners (Saito 14-15; "CHINESE in…"). In the case of Chae Chan Ping, commonly known as the Chinese Exclusion Case, the Supreme Court upheld the government's plenary power to enforce racially discriminatory laws that barred even legal residents like Chae Chan Ping from re-entering the U.S. after a brief visit abroad. Meanwhile, the case of Wong Kim Ark established an important precedent for birthright citizenship, asserting that children born in the U.S. to foreign parents were indeed U.S. citizens, challenging the notion of perpetual foreignness and racial ineligibility for citizenship for Chinese Americans (Thomas 711).

The Chinese Exclusion Act was further compounded by the Geary Act in 1892, which not only extended the exclusion for another ten years but also required all Chinese residents in the U.S. to carry a certificate of residence or face deportation—a manifestation of institutionalized racism and an early example of racial profiling (Pegler-Gordon, 56). By the 1917 Immigration Act, xenophobia, which deeply affected Chinese communities across the nation, was entrenched in immigration law (Lee, 559). For example, the 1922 Cable Act automatically assigned a woman the citizenship status of her husband upon marriage, thereby depriving women of autonomy, discouraging interracial marriages, and effectively prohibiting marriage between Chinese immigrants and other Americans (Moloney, 272).The extensions and modifications of the exclusion laws perpetuated a sense of alienation among Chinese immigrants, many of whom felt trapped between not being accepted as fully American due to pervasive racism, yet also distanced from their homeland of China. This alienation was complicated by the U.S. legal and social landscape, which in turn muddled the Chinese American ability to form stable, recognized communities and identities within American society (Song, 385-86).

These legislative barriers and court rulings, which embedded discriminatory practices into the fabric of American law, significantly influenced the lives of Chinese Americans. The perpetuation of such exclusionary laws not only entrenched racial discrimination but also deepened the sense of alienation among second generation Chinese Americans.

The Turn of the 1930s and the Emergence of a Chinese American Identity

The first Chinese civil rights organization, The Chinese Equal Rights League, had, among its goals, a desire for Chinese Americans to be treated equally as Americans (Chinese Equal Rights; Appeal; Zhang 137). However, the equity of this

identity remained elusive (Q. Chan 42). Indeed, Chinese Americans were othered and subject to social and institutional racism (Q. Chan 137-8). Chinese American youth in the 1930s often felt the two sides of their identities were "irreconcilable" (Q. Chan 141). The media representations of Chinese Americans during the 1930s exhibited a stark dichotomy of fascinating but unwelcome, oscillating between portrayals of “integral, if exotic” outsiders and vilified depictions as unclean drug fiends (“163 CHINESE…”). This polarized media portrayal mirrored the complex societal attitudes of the time. On one hand, American society could occasionally recognize the contributions of Chinese Americans, albeit often framing them within an exoticized context that emphasized their otherness. On the other hand, sensationalist journalism frequently depicted Chinese Americans as involved in criminal activities, particularly focusing on opium dens, which reinforced racial stereotypes and perpetuated a narrative of moral and social inferiority (“TROUBLE in ORIENT…”). Up until the Great Depression, the Chinese American elites—typically composed of merchants and community leaders closely aligned with the interests of their homeland—possessed “greater abilities and opportunities than the common laborer to cross racial, geographic, and even gender boundaries (Q. Chan 370). However, even elite Chinese Americans felt largely estranged both in the United States and in China; the American dream and upward financial mobility was not as readily available to them as white citizens, and American naturalization caused a significant cultural and social departure from mainland Chinese citizens (S. Chan 115). A second generation of Chinese Americans came of age during the Great Depression and realized the need for collective action (S. Chan 117). Unlike the previous generation, they lived in the United States from birth and desired a supportive community both within their ethnic group and within broader American society. The Great Depression had incentivized Chinese Americans to create labor groups to protect their communal economic stability (Song 386-7).

Organizations such as the Chinese Unemployed Council, the Chinese Hand Laundry Alliance, and the Chinese American Restaurant Association of Greater New York emerged as powerful platforms for advocacy and change (Song 387; Kwong 55-75). These groups shifted control of community identity away from the traditional Chinese American elite and towards the working and middle-class Chinese American citizens who increasingly saw their futures tied to the broader tapestry of American life.

Changing Representation for the Emerging Chinese Americans

Film as a medium is fundamentally intertwined with cultural expressions and societal norms, effectively mirroring the historical and social dynamics of its time. The study of film can unveil significant aspects of social and political history, positioning American cinema on par with written literature in its capacity to articulate national myths and societal concerns (Sobchack 280-293). Thus, American film is equal to any form of written literature in its

ability to represent American values, animate American mythology, or to express overtly or symbolically the preoccupations of American experience (Sobchack 290).

During the Golden Age of Hollywood, films were particularly reflective of prevailing American values due to strict adherence to the Motion Picture Producers and Distributors of America's Production Code, or "the code." This code mandated that films avoid "offensive social, political, and sexual themes," thereby ensuring that cinematic content upheld the moral and cultural standards of the time, which centered around government, church, and family (Black 167-171). These regulations suggest that the portrayal of Chinese Americans in films from this era was indicative of widely accepted societal views.

Though flawed, portrayals of Chinese and Chinese Americans in film can trace increased societal integration of these groups in the 1930s, specifically in The Mysterious Dr. Fu Manchu (1929), Daughter of the Dragon (1931), Charlie Chan at the Opera (1936), and Daughter of Shanghai (1937). As these interwar films made evident, film and propaganda have the potent power of shifting public opinion (Bernays 82). Therefore, these films may not only mirror the legislative changes affecting Chinese Americans but also may have served to shift public perception towards a more inclusive understanding of American identity. The careers of Warner Oland and Anna May Wong, who represented contrasting images of Chinese Americans, give glimpses into the prevailing public opinion toward Chinese Americans. These films progressed from stereotypical depictions to more nuanced portrayals, reflecting the evolving social acceptance of both Chinese and Chinese Americans due to wartime interactions with Asian countries (Shim 391). It is possible to both dissect the portrayal of Chinese Americans in key Hollywood films and analyze the broader racial ideologies and societal attitudes of the time. As reflections of American society and social conventions, the films allow for a glimpse into the complexities of racial integration and immigration policy within the Exclusion Era.

The Mysterious Dr. Fu Manchu (1929) and Early Manifestations of Orientalism

In the 1920s, public support for Chinese immigration to the United States was middling at best. Chinese American men were often relegated to roles traditionally considered "women's work," such as domestic labor and railroad work, which effectively emasculated them (Ma 46-47). During the Sino-Japanese War, the United States at first maintained a neutral stance; although, some commentators expressed a preference for Japan to "clean up" China ("JAPANESE BOYCOTT…"). This period also saw the rise of Orientalism, a concept later defined by Edward Said in 1976 to describe the West's depiction of the East as exotic, dangerous, and inferior—a result of longstanding colonial attitudes. Western media's portrayal of Asia, intensified by globalization and paranoia over a perceived Asian threat to domestic labor post-World War I, grew increasingly distorted (Aoki 35-36). Simultaneously, the

1924 Johnson-Reed Act exacerbated restrictions on Asian immigrants, establishing stricter immigration quotas and forming a Border Patrol to enforce these laws. This act also birthed the term “illegal alien,” a term still used in the modern day to degrade immigrants (Foner et al. 630). In implying immigrant existence itself rather than undocumented migration as “illegal,” the pejorative phrase further socially isolates immigrants in a country they are already not native. This legislation followed 42 years after the Chinese Exclusion Act, during which time several generations of Chinese Americans were born in the U.S., some without ever visiting China (Liang 23).

The portrayal of Chinese characters in Western media during this era was heavily influenced by the British Dr. Fu Manchu series, which began in 1912 and became widely known in the U.S. through the 1929 film adaptation, The Mysterious Dr. Fu Manchu (Sohn 5).The character Dr. Fu Manchu, described as embodying “all the cruel cunning of an entire Eastern race,” was portrayed as a malevolent figure, the epitome of “Yellow Peril,” the idea that foreign East Asians would “take over” white America (Rohmer 26; Shim 387-388). This representation marked the first significant Chinese supervillain in American pop culture, setting a precedent for the portrayal of Chinese Americans. Warner Oland's portrayal of Fu Manchu, with his exaggerated and sinister characteristics, reinforced stereotypes and underscored America's racialized view of citizenship and belonging. His performance in "yellow-face" demeaned Asian American actors, reducing their roles to that of simple caricatures or side characters. In The Mysterious Dr. Fu Manchu, the character seeks revenge against the Petrie family, whom he blames for his own family's demise during the Boxer Rebellion. Using a young white girl, Lia Eltham, whom he manipulates following the Boxer Rebellion, Fu Manchu fully embodies the Orientalist stereotypes of exoticism, mysticism, and the dangers tied to this perceived foreignness; ultimately, Fu Manchu even kills General Petrie with poison gas concealed in a tobacco tin, almost magically able to conjure a means of death.

Furthermore, the casting of Warner Oland, a Swedish-American actor, as Fu Manchu underscores the era’s racial and ethnic biases. An immigrant himself, Oland's selection over potential Chinese actors illustrates the phenotypical and racial prerequisites that defined American perceptions of citizenship and belonging at the time (Obituary). His portrayal reinforced a spectacle of the Chinese identity, exacerbating the overt racism and skepticism towards Chinese individuals deemed unsuitable for complex, nuanced roles. Instead, these roles were often diminished to simplistic, auxiliary characters or extras, reflecting the broader societal marginalization experienced by second-generation Chinese Americans during this period (Moon 616).

Female Representation and Dual-Identities in *Daughter of the Dragon* (1931)

In the 1930s, Chinese American women began to redefine their roles both

within their families and in society. Liberated from the strict oversight of their mothers-in-law and the traditional male-dominated family structure, these women joined men in operating family businesses, signaling a shift toward more egalitarian dynamics (Wang 189). This transformation in the Chinese American community mirrored broader changes across America, where women were increasingly recognized as essential contributors, particularly during wartime. Like their white counterparts, Chinese American women actively engaged in wartime efforts and were seen as valuable workers, gaining new credibility and respect within the broader society (Zhao 146-149). This evolving social landscape also had its reflection in the entertainment industry, though with complex undertones. Following the success of the Dr. Fu Manchu franchise, Anna May Wong's rising career provided her with unique opportunities, albeit within the constraints of the times. In Daughter of the Dragon, Wong portrayed Ling Moy, Fu Manchu's long lost American-born daughter, a role that both perpetuated and complicated the Dragon Lady stereotype (Moon 168). While Ling Moy was depicted using her allure and cunning in villainous ways, Anna May Wong's starring role broke significant ground. Notably, the film's title and credits did not prioritize Warner Oland as Fu Manchu but instead highlighted Wong, indicating her primary importance despite the problematic nature of her character's portrayal.

The film showcases Ling Moy as a "celebrated oriental dancer," dressed in attire that emphasized exotic mysticism appealing to Western audiences. Daughter of the Dragon explores Ling Moy's dual-identity by juxtaposing a "Chinese" and "American" life through her romantic relationships. As she grapples with the sudden knowledge of her father's vengeance, she must choose between the modest life she has always known as a Chinese American or feed into her father's Orientalist desires of killing the western man. Throughout the film, she is unable to fully commit to killing Ronald Petrie because of her love for him, directly conflicting with her father's dying wishes, even going so far as to attempt suicide from her distress. To avoid suspicion, she also charms detective Ah Kee, somewhat feeding into the Dragon Lady stereotype of using her sexuality as a means to manipulate men. Ah Kee is much "smitten with the alluring Ling Moy," but ultimately chooses the safety of the Petries over pursuing their love (Fu Manchu's Daughter). Her father's right hand Lu Chung emphasizes that "one foot cannot stand in two boats," meaning that she must confine her allegiance to one "side" – either the American Petrie or the Chinese Fu. This portrayal, while catering to stereotypical expectations, also allowed Wong to exhibit a complex character grappling with dual identities. "Daughter of the Dragon" explores these conflicts through Ling Moy's relationships and her struggle between her inherited obligations and her personal affections, particularly her love for Ronald Petrie, which ultimately prevents her from fulfilling her father's vengeful mission.

Race-based legal restrictions were reflected in Hollywood code: "offensive" themes like miscegenation were banned from appearing in film (Perry, Sutton 251).

With the ban on interracial sexual relationships, the codes aligned Hollywood with anti-miscegenation laws and restricted Asian American actors from taking on a larger range of roles, thereby typecasting Wong into racist roles (Lim 69). Despite this, Wong's performance was critically acclaimed, setting her apart from her peers and marking a significant, if incremental, progress in the portrayal of Chinese American women in Hollywood (Babcock). The more meaningful representation of Asian American women in film was a firm advancement for Chinese American women from portrayals in the early 1930s.

Inching Towards Acceptance with *Charlie Chan at the Opera* (1936)

In the 1930s, the portrayal of Chinese Americans in Hollywood began to subtly shift, moving from explicitly negative stereotypes to more complex characterizations. During this time, the Charlie Chan franchise emerged as a best-selling franchise in the US (Rzepka 1463). Warner Oland's portrayal of Charlie Chan in “Charlie Chan at the Opera” (1936), directed by H. Bruce Humberstone, exemplifies this change. Despite the continuation of problematic elements like yellowface and the use of stereotypical accents, Charlie Chan emerges as an unlikely hero—a departure from earlier, more villainous representations. Charlie Chan, a character described by Charles J. Rzepka as part of a formulaic subgenre of crime fiction that perpetuated racist stereotypes, nevertheless represented a significant evolution in the portrayal of Chinese Americans (Rzepka 1464-71). Positioned as a competent detective, Chan navigates societal prejudices and professional challenges with humility and wisdom, often employing Confucian proverbs (Rzepka 1471-73). This nuanced portrayal contrasts sharply with previous depictions, signaling a gradual shift in how Chinese Americans were viewed in popular media. Significantly, Chan's role as a detective within the Honolulu police force marks a notable departure from the past. His interaction with other characters in the film highlights changing social perceptions. For instance, when a fellow officer derogatorily refers to Chan as “Chop Suey,” his superior reprimands him, suggesting Chan's valued contributions and respected position within the team. This scene is pivotal as it illustrates a move towards acceptance and respect, contrasting sharply with the outright discrimination of earlier films. Chan's characterization still embodies certain Orientalist stereotypes, such as equating politeness and submission with Chinese traits. However, the advocacy by authoritative figures for Chan and his inclusion in a quintessentially American role as a police detective contributed to enhancing the public perception of Chinese Americans, signaling their emerging acceptance as integral members of American society.

This portrayal of Chan came during the Great Depression and the subsequent implementation of the New Deal catalyzed political activism among Chinese Americans. The formation of advocacy groups such as the New York Chinese American Voting League exemplifies this shift. These organizations mobilized to

support New Deal initiatives, thereby asserting a burgeoning political agency and presence within the Chinese American community (Song 389). This period of increased political engagement coincided with a resurgence of nativist sentiment, particularly among government officials. Senator Martin Dies Jr. of Texas exemplified this perspective, arguing that the economic hardships of the era were exacerbated by the presence of immigrants. He contended that without the 16,500,000 foreign-born residents, the United States would not face unemployment issues, and he advocated for the deportation of 6,000,000 immigrants to alleviate economic strain (LaGumina 60-61).

Furthermore, to once again consolidate their place as "true Americans," Chinese Americans turned to political participation. Organizations such as the rising New York Chinese American Voting League rallied in political gatherings in support of the New Deal policies (Song 389). Especially telling was their campaigning for Roosevelt in 1932 and the November 1936 Presidential election, which was one month before Charlie Chan at the Opera was released. Roughly three quarters of the total eligible Chinese voters cast votes in the 1936 election. This mobilization to vote represented a broader desire for Chinese Americans to assert their political presence. Amidst this context, the character of Charlie Chan is more telling of a developing Chinese American identity that was distinctly separate from that of immigrant Chinese. Chan's positive reception among American audiences indicated not only a shift in the portrayal of Chinese characters in media but also the beginning of a broader acceptance of Chinese Americans as integral and established members of American society.

Distinguishing Chinese-American and Chinese in *Daughter of Shanghai* (1937)

In Daughter of Shanghai, Anna May Wong portrays Yan Ling Lin, a character that represents a significant evolution in the depiction of Chinese Americans in Hollywood, in particular due to its finally depicting Chinese American women as strong, intelligent, and integral members of American society. This 1937 film, directed by Robert Florey, diverges from

conventional narratives by positioning two Chinese American characters, Yan Ling Lin and Detective Kim Lee, as protagonists working against an illicit smuggling ring targeting Asian immigrants. Unlike previous portrayals, the film casts the smugglers as the villains rather than the immigrants, a poignant political criticism of the scapegoating of immigrants for economic and social issues rather than addressing the systemic issues enabling such crimes.

Yan Ling Lin is presented as a competent and intelligent figure, a departure from the stereotypical roles assigned to Asian women in earlier American cinema. Courageously placing herself in the backdrop of a burlesque tavern as a dancer to investigate her father's death, she inverts Orientalism by using her sexuality as a means for an altruistic desire to dissolve the smuggling ring. Her confrontation with Olga

Derey, a white burlesque dancer who antagonizes her, highlights the racial tensions of the period but also underscores Yan Ling's resilience and acceptance by other characters in the film. This interaction, and Yan Ling Lin's ultimate uncovering of the smuggling ring's mastermind—her close friend Mrs. Mary Hunt—culminates in an offer for Yan Ling to work in Washington, presumably in a governmental investigative role, signaling recognition of her capabilities and embodying the integration of Chinese Americans into American societal structures. Daughter of Shanghai stands out not only for its progressive portrayal of a Chinese American woman as the hero but also for its female-centric narrative, a rarity at the time. The film's focus on women in dynamic roles challenges the traditional gender norms prevalent in the cinematic portrayals of the era, contributing to a broader narrative of empowerment and change within the Chinese American community.

The film's portrayal of Yan Ling Lin's emergence from a model to a detective following her father's death aligns with cultural narratives of individual independence emerging through personal loss. This theme resonates with Dinkar Burathoki's analysis of post-war media, where familial loss often catalyzes personal growth and independence, particularly in narratives centered around male protagonists (Burathoki 137). However, Daughter of Shanghai subverts this trope by centering a female protagonist, reflecting the shifting dynamics within Chinese American families and broader societal roles for Chinese American women during this period; Chinese women were allowed to take on jobs typically occupied by men, and in doing so, could demonstrate their allegiance to the country they resided in, but were not always were citizens of (Zhao 139). Additionally, Chinese American women emerged as real life leaders in the household. Now living in America, young Chinese women ceased interaction with their mothers-in-law, who were second in command only to the male head of the family, and found themselves in a new independent position of power (Ling 46-49). Nuclear Chinese American families often opened businesses together like laundromats, restaurants, or grocery stores, splitting responsibility somewhat evenly (Ling 47-48).Chinese American children played a particularly important role in the family as translators and interpreters with their ability to learn English quickly, upsetting parent-child power dynamics and in turn acculturating their parents (S. Chan 128). The film's depiction of Chinese American characters and its break from traditional gender and familial roles signify a pivotal moment in the portrayal of Asian Americans in media. It reflects the changing perceptions of Chinese Americans from peripheral figures to central, integrated members of American society, capable of leading narrative and societal change. This progression in media representation mirrored real-life changes where Chinese Americans, particularly women, began to occupy roles that were traditionally denied to them, both in public and private spheres.

Following a romantic English banter in the concluding scene, Kim Lee and Lan Ying switch to Taishanese and solidify their future relationship by affirming their plans

for marriage. This dialogue is left untranslated, likely intended for a Chinese American audience. Unlike narratives of the past, Anna May Wong was finally able to subvert anti-miscegenation codes by romancing an on-screen Chinese man rather than killing or unrequitedly pining after a white love interest. Abandoning Orientalist manipulation or mysticism, their budding relationship represented a broader change towards finding normalcy within Chinese American domesticity. Thus, Daughter of Shanghai represents the broader acceptance of the unconventional Chinese American social structure within American society, a progressive film recognizing Chinese Americans as integral members of the American fabric.

The Good Neighbor Relationship: The Repeal of the Chinese Exclusion Act

Five years subsequent to the release of Daughter of Shanghai, the repeal of the Chinese Exclusion Act represented a significant legislative transformation, partially precipitated by shifting social perceptions of Chinese Americans, as reflected in the film's portrayal of them as patriotic and relatable figures. This cinematic depiction, emerging just months prior to notable shifts in public sentiment, corresponded with an increase in American empathy towards Chinese Americans during the escalation of the Second Sino-Japanese War. A substantial growth in public sympathy towards Chinese Americans was reported as Japan intensified its military actions. In both 1937 and 1939, those aligned with Japan in the conflict comprised only 2% of the sample size (“Americans neutral…”; “THE SINO-JAPANESE WAR…”). Polls of Americans aligned with China increased from 47% to 74%, meaning that those unaligned had now taken a stance in support of China amidst escalating international conflicts and Japan's militaristic expansion in Asia (Ma 46-47; “15,000,000 AIDED…”). Notions towards Chinese people had shifted from outsiders to those in need of aid. In the same newspaper, the Church Committee for China Relief had spent over $5,000,000 in helping Chinese refugees. The Chinese had “enjoyed the sympathy of the whole world,” which reflected similarly on the public perception of Chinese Americans (“REVIEW…”).

As World War II intensified, concerns grew over the Chinese Exclusion Act's potential to drive China towards an alliance with Japan, threatening Chinese-American diplomatic relations (Leong 5, 8). This period saw a reevaluation of American immigration policies as part of broader efforts to fortify the alliance between the U.S. and China. The repeal of the Chinese Exclusion Act in 1943 was a crucial step towards fostering national unity and acknowledging China as a key ally against the Axis powers. This legislative change, though primarily symbolic, marked a significant shift in American policies towards a more inclusive approach to its Asian residents, contrasting sharply with the continued escalation of anti-Japanese sentiment post-Pearl Harbor (Pascoe 61). However, despite these advances, significant legal barriers remained for Chinese Americans, who continued to face widespread discrimination in employment, property ownership, and broader civil rights.

This discrimination was legally sanctioned by various restrictive laws that persisted until challenges such as the landmark case Perez v. Sharp in 1947 began to address their constitutionality. This case marked a pivotal moment in civil rights law, paving the way for greater legal recognition of the rights of minority groups in America (Wang 189).

Although the journey towards genuine equality and integration for Chinese Americans was protracted and fraught with ongoing challenges, films such as Daughter of Shanghai noted the shift of public perceptions of Chinese Americans during the 1930s. This eventually culminated in the repeal of the Chinese Exclusion Act marking a critical, yet initial, step towards dismantling the legal barriers that had long segregated and subjugated Chinese Americans within their own country (Song 402).

Conclusion

The exploration of Chinese American portrayals in Hollywood films from the 1920s and 1930s provides a complicated means of tracing the evolution of racial representation and its broader societal implications. The dynamic interplay between cinema and societal attitudes reveals how deeply entrenched racial perceptions can subtly and overtly shape media content. Early cinematic portrayals, such as those in The Mysterious Dr. Fu Manchu (1929) and Daughter of the Dragon (1931), were heavily influenced by prevailing stereotypes of the “Yellow Peril” mystique. These representations were marked by a distinct otherness, aligning with the societal anxieties and prejudices of the time. However, the work of organizations like the Chinese Equal Rights League and the Chinese Hand Laundry Association reflected a significant shift in the concept of Chinese American identity during this decade. This shift became increasingly apparent in later films like Charlie Chan at the Opera (1936) and Daughter of Shanghai (1937), where sinister representations evolved into more complex and even heroic figures, and main Chinese characters began working for significant American institutions. This evolution signifies a gradual (albeit incomplete, due to inequitable compensations for Chinese American actors within the film industry) societal shift towards more nuanced understandings of Chinese American identity, particularly for second-generation Chinese American women. As the socio-political landscape evolved, particularly with America's altered stance towards China during and after World War II, so too did the portrayal of Chinese American characters in film. The films began to challenge previous stereotypes, introducing characters that were more integrally woven into their storylines with attributes that appealed to American values of heroism and resilience. This indicates that, even within the constraints of the Hollywood Production Code—which reinforced the moral standards of the time—there was a pivot towards Americans' increased acceptance of the Chinese American identity.

Cinema serves as a powerful cultural mirror, reflecting societal values, tensions,

and transformations. The nuanced portrayal of Chinese Americans in Hollywood films serves as cultural proof of increased acceptance of the Chinese American identity, through which one can trace the contours of racial understanding and prejudice, highlighting both progress and the persistent challenges that remain. Although media today still often struggles to provide great representation, this analysis enhances our understanding of racial dynamics in cinema and contributes to our broader historical knowledge, so we can continue to progress both socially and artistically. By examining how these portrayals have evolved, we gain insight into the complex interplay between race, Hollywood, international relations, and domestic policy. The interwar period emerges as a significant marker of Chinese American unity, reflected in improved film representation and the repeal of discriminatory laws, as well as American societal shifts towards Chinese acceptance. The recognition of the Chinese Exclusion Acts as being rooted in racism was a major shift within this time and represents a significant triumph in Chinese American civil rights. As President Roosevelt noted in his 1943 address to Congress on the repeal of the Chinese Exclusion Act, "nations like individuals make mistakes, and we must be big enough to acknowledge our mistakes of the past and to correct them" ("President Urges…").

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The Artificial Intelligence Revolution in Retail

Ella Pintar

Abstract: In this paper, I will discuss the fundamental changes made in the retail world due to the addition of artificial intelligence (AI) to our current economy. AI has revolutionized the way in which we live in all aspects of our everyday lives. Retail as we know it has transcended into an ever-evolving wave of efficiency. The world has changed, whether for online shopping, faster service, or even optimizing business strategies from the seller's advantage. The method used to gather information for this study was through internet search engines, online databases, and personal experience. The research findings allow for a comprehensive review of why AI has changed the retail world in the 21st Century and what our future expectations can look like as AI continues to advance. By examining the profound impact AI has had on the retail world, this paper will dive into the strengths and challenges that come with the implementation of AI.

Introduction

Artificial Intelligence (AI) has quickly become one of the world's fastest-growing industries. AI is commonly defined as an advanced computer system that is able to complete tasks that would require a human to complete them successfully. AI can be seen in action through chatbots, predictive analytics, recommendation algorithms, etcetera. Retail is a booming industry "valued at USD 27.155 Trillion in 2022 and projected to reach a value of USD 40.735 Trillion by 2030" (Vantage Market Research). The rapidly changing AI technology is only altering and advancing how these businesses operate. With these advancements, consumers expect highly personalized and efficient experiences. AI has made it as easy as chatting with an online robot to assist with any needs instead of calling the operational service department for hours. With minor adjustments like this, the everyday lives of people all over the world have changed significantly. However, there are many future implications to consider. As AI further advances, it will continue to take over the retail world, allowing for even more personalized suggestions. Although, this raises the question of personal privacy and

ethical issues with tracking data and behavior. It is also possible that consumers may feel overwhelmed with the plethora of suggestions they receive from all of the AI marketing strategies. For the purpose of this paper, I will discuss how AI has made a significant contribution to the retail industry with increased efficiency, customer engagement, and fraud detection. Whether or not brands chose to integrate AI into their business strategy, AI is becoming an increasingly common tool that is a driving force for many large corporations today. Nevertheless, ethical considerations and job displacement must be addressed in order to gain a holistic perspective on the impact of AI in the retail market.

The Evolution of AI in Retail

Retail Before AI

Before AI, all inventory tracking, consumer data analytics, and marketing were done manually. Hence, there was a high demand for human labor in order to properly run a business. Whether it was a sales associate counting the number of egg cartons or a marketing executive creating a billboard for Times Square, it all had to be done by hand. Now, a lot of the mundane but time-consuming tasks can be completed or expedited through the use of AI. Businesses are not able to survive using their current business models, excluding AI, when there are such large competing platforms like Amazon, which significantly integrate the use of AI, which is a one-stop shop from your own couch (Forbes).

AI Adoption in Retail

When AI was first adopted in retail, it began as a driving force for product recommendations. Users of various platforms would get product suggestions based on their previous purchases or what they had viewed. This was not only a marketing tactic for businesses but also a more effective and efficient shopping experience for consumers. For example, AI has substantially affected even the most simple tasks like grocery shopping. Now through Instacart, an "AI assistant is able to suggest dinner ideas, generate a shopping list, and [convert] it into an order delivered to your door" (Forbes). With simple tasks like this becoming substantially more straightforward and more efficient, there is more time in the day that can be allocated for more work or spending time with family. Not only that, but AI can maintain and manage inventory levels for businesses by tracking the projected demand for goods and ensuring that they are sufficiently stocked. AI is at the forefront of consumer segmentation, making marketing and business data more straightforward. All of these calculations and evaluations can be done in the background, allowing people to focus on the most important tasks in real-time.

AI's Impact on Key Retail Areas

AI in Customer Experience

Customer service has become substantially more efficient and accurate due to the integration of AI in retail. Rob Garf says, "When deploying AI, whether you

focus on top-line growth or bottom-line profitability, start with the customer and work backward" (Salesforce). Essentially, the consumer should be at the forefront of everything businesses do. With now fully online customer service accounts that help instantaneously, there is no need to call and join a waitlist or make sure the store's hours fit your schedule; help is available 24/7. Moreover, speedy checkouts accounted for by AI enhance the consumer experience by memorizing card details from past purchases, making it even simpler to complete an online order. Additionally, personalization and recommendations are a large bonus to all consumers. AI can create a personalized list of recommended items/services tailored to your wants and needs through AI's analysis of customer behavior, purchase history, and browsing patterns. Retailers such as Amazon, Sephora, and Ulta use this type of technology to create virtual customer relationships. This creates a further sense of brand loyalty because the consumer can feel like the brand understands and aligns with their wants and values.

AI in Inventory and Supply Chain Optimization

Any large or small retail businesses must spend much time on their stock count. This is a slow and tasking job that is very inefficient. Now, with AI, it has never been easier. Target's CEO Brian Cornell says, "We have a unique model where 95% of our sales are filled by our stores, and it has created new opportunities because we can embrace AI" (The Sun). Now, they do not have to use the workforce to ensure there is no risk of a shortage or overstock, which in turn saves lots of money. One, because they do not have to pay AI to do the job, and two, they can reallocate the employee to more pressing tasks. This revolutionary change has wholly shifted how businesses can keep track of their supply and increase their efficiency. This creates less variability for possible mistakes and mess-ups, which also decreases their profit margins that may have to be allocated for issues with supply and demand. In fact, AI has also helped reduce out-of-stock situations by 30%-50%, which helps close the margin of lost profits (Statista).

AI In Marketing and Consumer Engagement & Fraud Protection

AI’s ability to align with industry prerogatives in efficient personalized marketing campaigns, perpetuates brands to stay relevant in a fast changing world; yet, AI fails to replicate human connection, subsequently lacking human rationale. We live in a world where trends are constantly changing, and for brands, this is both negative and positive. It is harmful because right when brands find a niche way to engage in the trend, the world has already moved on to the next, making it challenging to continue to be relevant. However, this is also a positive because there is always an opportunity for brands to engage with their targeted marketing segment in ever-evolving ways. Despite the fact that AI maintains brands ability to stay relevant, AI is unable to replicate human feelings, emotions, and empathy creating a significant challenge in truly targeting market segments and creating customer relationships, thus, making it

difficult for AI to relate to the consumer on a personal level. The way AI cultivates personalized marketing strategies is through their expansive data collection, allowing companies to keep up with the latest trends. The specific data collection is only made possible through the input of human experience. Whether it be from tracked customer behavior or employees using AI as a tool for enhancement, the need for human activity is still prevalent. Although concerns of privacy and ethical boundaries become questioned with the use of AI, the increase in fraud protection is able to prevent viruses and hacks imposed on consumers' devices. AI is able to strengthen cybersecurity by blocking any hazards instantaneously. By increasing the amount of security, consumers will feel more comfortable to use online retail platforms. As the world continues to evolve, the use of technology will continue to grow, which is why it is important to have secure cybersecurity.

Statistical Comparison - Retail Before vs. After AI

Before AI, marketing campaigns were generally directed by manual marketing strategies, in-store campaigns, and broad marketing segments. However, with the implementation of AI, marketing has now become highly personalized and faster than ever. According to Statista, retailers implementing AI into their marketing strategies have seen double the sales growth compared to strategies that leave out AI. Additionally, in the case of Amazon, 35% of total sales are made by AI-powered recommendation engines (Forbes). The example of Amazon is critical because it is in a global marketplace. Amazon is a driving force for efficiency in today's day and age, and they have found a way to make it faster and more personalized. With sales doubling, there is no question that AI is making a drastic impact, not only on retail from the consumer, but also on the seller's side.

Challenges and Ethical Considerations

Due to the increase in AI within the retail market, there is an increase in structural unemployment. Specifically, jobs such as warehouse management, cashier, and service assistant are limited and not necessarily needed since AI is able to do their job more efficiently and for free. This then causes a higher rate of unemployment and the need for more jobs. As AI continues to advance, future jobs in marketing may also begin to suffer. With the development of personal AI robots for individual companies, there will be an endless cycle of unemployment perpetuating. However, AI will never be able to fully replace human jobs because although AI is able to learn and complete tasks, it does not and will never have the empathy and emotions that humans have and use in their everyday lives.

With the advancements of AI comes more and more information gathered from the consumer. With individualized suggestions from AI, the consumer is met with an algorithm which suggests many personalized services and products creating a seemingly overwhelming experience for the consumer. When met with significant amounts of suggestions, it is possible for the consumer to get distracted from their

targeted task. Further, no matter how many times you click on a website, purchase history, or recent searches, everything is tracked in order to create the most personalized and optimal marketing segmentation. This raises the concern of whether AI is ethical and if it is breaching consumers' privacy. The reason AI is so powerful is its ability to learn patterns and create highly personalized algorithms, which would not be possible without personal consumer information. On the contrary, it is a fundamental human right to have privacy, which is necessary for personal autonomy and protection (The Digital Speaker).

Conclusion

The limitation of this study is that AI has not been around long enough to do a full-depth, long-term review of its effects. AI continues to advance every day and will continue to advance for the foreseen future. Since AI implementation in retail is a rather new phenomenon, there is not enough long-term data to see how it will affect customer relationships over larger periods of time. However, we are able to make accurate predictions from the data we do have, since they are such strong statistics that show clear changes with AI implementation. Ultimately, AI has revolutionized the world of retail. From efficiency to marketing to optimization, AI has done it all. AI has driven substantial improvement in sales, productivity, inventory management, and customer engagement from a more personalized experience. Whether it be in the cases of Amazon and Target or even small start-ups that are utilizing the same technology, everyone needs AI to advance in the retail world. Although companies need to be mindful of unemployment rates, AI is still a helpful tool that can be used to enhance the human mind rather than replace it. AI is not just used for retail but is actually a tool for everyday life, computer science, architecture, teaching, and any other industry. When used correctly, AI is a tool that can be trained to make tasks and daily life easier in order to save time on completing mundane, tedious tasks. However, as I have mentioned previously, AI will never be able to create full structural unemployment because AI only exists with the input of humans. It requires humans to prompt it in order for it to act in the appropriate manner. Additionally, AI lacks human connection and feelings, which are fundamental life skills. In all, AI is a helpful tool that will continue to be used in retail for years to come and will continue to advance the world as we know it.

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A Place to Call Home

Kameron Pham

Abstract: This study investigates how California, primarily Los Angeles, can effectively address the homelessness crisis. Current solutions fail to address key factors contributing to homelessness, such as the recent COVID-19 pandemic, mental health, unaffordable housing costs, medical debt, natural disasters, domestic violence, and poorly budgeted government spending. This report evaluates the shortcomings of Mayor Bass's Inside Safe program and introduces the possibilities of longer term solutions such as affordable housing and career-building programs. Research findings include that there is significant room for improvement regarding the city's budgeting, as half of Los Angeles's 2023-2024 homelessness budget — $1.3 billion — went unspent. Results reveal that Los Angeles's homeless shelters are dangerous and poorly managed. This paper also examines successful homeless-prevention models, particularly Finland's "staircase" model, which prioritizes the treatment of an individual's health and wellbeing on a long-term path to recovery from homelessness. Finland tackles homelessness at the root and establishes more permanent solutions, setting a role-model for success. By implementing Finland's strategies, and allocating funds more effectively, California can address underlying causes of homelessness rather than trying to persist with short-sighted programs that emphasize temporary fixes.

Introduction

We see them everywhere we go. These people who dream of comfortable houses from their cardboard homes under the 405 freeways, living out of their soon to be repossessed cars, shopping carts filled to the brim with eclectic finds in parks, and sleeping bags on benches inches away from media conglomerate headquarters. For miles in every direction until you see the skyline, you will see nothing but tent cities and people sleeping in cardboard boxes. We see them on every street and wish we can do something, but we always ask ourselves, what can we do?

With over 200,000 homeless people in Los Angeles alone, approximately 30% of the homeless population in all of America,

the homeless crisis seems insurmountable. However, such fixtures are not exclusive to Los Angeles. According to the National Alliance to End Homelessness, "From 2019-2023, the number of people who entered emergency shelters for the first time increased more than 23 percent" across the country. To make matters worse, extreme weather due to climate change has left 230,000 vulnerable, unsheltered individuals devastated, furthering the need for solutions (Klein et al.). Despite the urgency of this situation, lawmakers remain divided on plans to help unsheltered individuals get off the streets as rising rent prices and COVID-related financial hardships only compound matters further.

Rather than spending billions of dollars on short-term solutions, such as booking motel rooms for homeless people for a few nights, politicians should place more emphasis on affordable housing and career development — more permanent solutions to address the root of the housing crisis in America on a larger magnitude. Ultimately, we cannot put the future of our communities and the welfare of citizens solely in the hands of lawmakers who continue to ignore an issue that can be seen on almost any street corner.

Why Homelessness is so Prevalent in California

Homelessness arises through a multitude of intersectional social, and medical forces, the primary two being rampant poverty and astronomical housing costs pricing an already vulnerable population out of the housing market entirely. Motels alone will not even begin to resolve either issue, and instead, we need to think bigger, enacting long-term solutions that get to the root of the problem.

Currently, for every 10,000 people in California, 44 are homeless, which has earned California the country's highest homelessness rate, according to a study by CalMatters. In recent years, we have only seen an uptick in social, environmental, and economic disasters contributing to the homeless crisis across the nation. In 2020, the Covid-19 pandemic swept across the country affecting millions of lives; climate change continues to pose as an ever unpredictable threat; and citizens' inability to grapple with medical debt or access proper care for mental health issues all play major roles in exacerbating this growing issue, especially in a densely populated city like Los Angeles.

<u>The Covid-19 Pandemic</u>

Since March 2020, rising rent prices and Covid-related financial hardships have only exacerbated the homeless crisis in California, forcing many individuals onto the streets with nowhere to go and little to no resources to help them escape their circumstances. According to a study by Pew Research, the median monthly cost of rent alone increased by 12% from before the pandemic in 2019 to 2021. With rent prices in California already being relatively high with respect to the rest of the country, raising rents was in no way helpful or easy to navigate for those now potentially sick, possibly not working due to Covid layoffs, or simply unable to accommodate for such a

sudden shift in price. As a result, many individuals were forced to vacate their homes, in a time of mass political and social unrest. Many were forced into homelessness during this time, and in 2020 an analysis was done by the U.S. Government Accountability Office in effort to see the effects these rising rent prices had on Americans, finding that "a $100 increase in median rent was associated with a 9% increase in the estimated homelessness rate." Essentially, there is a direct relationship between rising rent prices and an increase in homelessness, especially when these elevated rent prices are not joined by raises in wages or generally lower costs. To this day, we are still dealing with the aftermath of the Covid-19 pandemic. There are still countless Covid cases each year, and the economy has never truly recovered. As a result, many displaced individuals are still on the streets, trying their best to get back on their feet.

Natural Disaster

Many states across the country are subject to natural disasters such as hurricanes, tornados, earthquakes, droughts, and a wide variety of other forces that only seem to be increasing in severity as time goes on. California, notably, has seen a rise in its number of wildfires per year, with the fires also seeming to increase in the amount of damage they cause. Already, "From 2020 to 2023, wildfires destroyed more than 15,000 structures in California" (Halpert). It is not easy to recover what has been lost after fires have burnt homes, schools, grocery stores and entire communities to the ground. Currently, as of January 2025, Los Angeles is still desperately tackling the devastation of two still active wildfires – the Palisades fire, in particular, being one of the largest wildfires the state has ever seen. Although the fires are nearly contained, "Officials have confirmed, so far, 6809 structures have been destroyed and 972 damaged" (Gamson). These fires have been an absolutely catastrophic issue for the city and will no doubt contribute to the ever-rising population of homeless citizens in LA. There is no telling when the disaster zones will be cleaned and new homes rebuilt. In the meantime, countless Los Angeles citizens are relying on the kindness of donations and various social programs for the aid they need to, at the very least, have clothes on their backs and something to eat. Yet, this does not mean that these individuals will be provided with living accommodations, and many will be left on their own to figure out how to find a new home with such little resources.

Health Crises & Medical Debt

There are also medical factors that play a major role in some individuals' decline toward homelessness. Those who suffer from certain physical or mental illnesses may not be able to afford or otherwise gain access to the care they need. Such individuals may find themselves unable to work or struggling to pay rent, ultimately resorting to a homeless lifestyle because there is simply no other option. As it sits, about "67% of homeless people currently have some form of mental illness, while 77% were found to have experienced mental illness at least sometime during their lives," a statistic which puts into perspective

how rampant mental illness truly is within homeless communities (Mundell). Again, many of these individuals are not homeless by choice, rather they have been oppressed by a system they simply do not have the tools, understanding, or help to handle. Even further, there are other individuals, who despite having possible access to certain degrees of medical help, are left piled high with incredibly unmanageable amounts of medical debt. According to a nationwide 2022 poll "about 100 million people have some form of health care debt. Of those, about 1 in 5 said the debts have forced them to change their living situation, including moving in with friends or family" (Levey). The idea that one may have to adjust their living situation for the worse in order to combat medical debt is not just possible, but incredibly common. And it is not easy to climb out of the hole of medical debt once in it. Even if one continues to adjust their living situation, it may only be a matter of time before a new procedure or medication causes them to fall over the edge into to homelessness.

Domestic Violence

As previously stated, the homeless crisis is an intersectional issue, bolstered by a combination of social, economic, and environmental factors, and gender is an additional layer to this discourse. One might lose their home from a natural disaster, debt, or illness, but victims of domestic violence also often find themselves in positions where they are ultimately homeless with about "38 percent of domestic violence victims [becoming] homeless at some point in their lifetime" ("Five Facts About…"). Our homes are meant to be our safe spaces, but sadly, that is not always the case. We may feel the need to flee from our homes, and it would be nice if there were more programs in place to help individuals in this situation rather than them succumbing to a homeless lifestyle out of desperation. Further, many of these domestic violence victims forced into homelessness are women, and homeless women tend to struggle even further as "more than 90 percent of homeless women have experienced severe physical or sexual abuse at some point in their lives" ("Five Facts About…"). Clearly, there is a devastating relationship between domestic abuse and homelessness, highlighting how homelessness is a common symptom for those who don't have the help they need from loved ones or society to find safety in times of struggle. This pattern truly underscores the need for special services and secure homeless shelters to address both housing insecurity and domestic violence.

Clearly, there is a devastating relationship between domestic abuse and homelessness, highlighting how domestic violence is yet another contributor to homelessness. With victims of domestic abuse more likely to experience homelessness, and in desperate need of safe places to stay, this pattern underscores the need for special services and secure homeless shelters to address both housing insecurity and domestic violence.

The Failed System of Homeless Shelters

One of the most common solutions to combat homelessness has been to create

and maintain homeless shelters—spaces intended to be safe structures offering temporary levels of housing. Although homeless shelters seem like the most plausible solution, there are several issues with the homeless shelter model that governments have relied on to fix the homeless epidemic. Not only is there not enough room to accommodate the homeless populations in various cities, but oftentimes, these shelters lack the resources and security to help homeless people find long-term housing and resolve mental health concerns. With regards to Los Angeles, only 17,225 homeless individuals are living in a permanent shelter, according to a study by the Los Angeles Homeless Services Authority.

Besides the lack of beds, homeless people have become victims of violent attacks carried out by other homeless individuals. In a survey completed by the National Health Care for the Homeless Council, "forty-nine percent of respondents reported being the victims of an attack." With regard

to being a homeless woman, many feel equally as safe on the streets as they do in these shelters with a 2019 study noting that "26.4% of women who slept most frequently in shelters also reported having experienced sexual assault in the last year, with another 23% reporting feeling unsafe in the shelters" ("Violence Against Women"). Essentially, although Los Angeles does have shelters for its homeless, they are incredibly rundown and relatively dangerous spaces to exist, hardly used by the people who need them most. Even further, these shelters rarely offer resources that can help individuals out of homelessness, serving only as brick roofs with occasional access to food and water.

Unfortunately, California's current models for homeless shelters are doing very little to actually help its homeless population. In many ways, homeless shelters have even become more of a liability than an enduring solution as they have transformed into tightly packed arenas for violent attacks.

Finland's Model — A Blueprint for Success

With the homeless crisis at its tipping point, California should take Finland as an example and implement their ideas to solve the homeless issue. Although the population of Finland stands at 5.5 million, only 3,429 remain unhoused whereas Los Angeles, with a population of 3.8 million, has a staggering homeless population of 75,518 (Hedley; Yee). Finland, with a greater population to care for, manages to greatly outperform Los Angeles in its ability to care for its homeless citizens. Finland, which also has one of the lowest homelessness rates in the world, ensures that unsheltered individuals are promptly placed in temporary housing as well as provided with resources to help them get back on their feet (Hancock). According to Greater Change, Finland also mandated that at least 25% of housing in a city must be affordable. In addition, according to Civil Beat, Finland reduces housing costs for all residents at the same time to combat the homeless crisis. As a result, the country has decreased its

homeless rate by 80% since 1986 despite its growing population.

That's not even all. As successful as Finland has been with its programs for homeless citizens, the country is still working toward improvement. The areas where Finland has not seen success – such as helping its people through mental instability, drug abuse, or other deeply rooted issues that lead certain struggling individuals toward homelessness – are being modified and addressed. Where before, Finland would prioritize finding housing for its homeless population, now more emphasis is being put on the treatment of a homeless individual's various physical and mental health problems; the idea here being that, with such health resources, citizens would be less likely to fall back into homelessness, as was sometimes still happening. Finland is now calling this the "staircase" model as it focuses even more heavily on each step toward recovery from a homeless lifestyle (Morales). As such, Finland is not only a great example of what we should do now to try fixing the Los Angeles homeless crisis, but also what we should continue to do moving forward. It is not to take a few steps, such as building shelters, and then to allow things to stagnate. We must constantly work to evolve our programs and help our fellow citizens through ever-growing times of hardship.

Although Los Angeles Mayor, Karen Bass, has already tried implementing her own plans in order to hopefully create new systems to help manage the homeless crisis, much of her work has been unsuccessful and leaves many questions unanswered as to how she plans to budget. After taking office in December 2022, she proposed Inside Safe, a homelessness program that sought to relocate the city's estimated 40,000 homeless people into independent and temporary housing like motels. Despite the nascent program's apparent successes, having already moved around 21,000 people indoors and provided over 3000 of them with permanent housing, simply building more housing and utilizing spaces such as motels will not solve the homelessness crisis altogether, an idea emphasized by many of the activists and housing specialists working to resolve the crisis ("Inside Safe"; "More Than 21,000…"). Ultimately, "nearly half of Los Angeles Mayor Karen Bass' record $1.3 - billion homelessness budget for fiscal 2023-2024 went unspent," meaning that, despite what little success the program did see, there is still an incredible amount of resources that are not being utilized correctly (Smith). What Inside Safe and programs like it are ultimately doing is addressing the symptoms rather than the underlying disease. These programs do not target any root issues of the homelessness crisis, and only waste valuable time and money that could be much better spent if just utilized a little differently.

Mayor Bass and the city of Los Angeles desperately need to take cues from Finland. At this point, Finland has shown the world multiple models of success, proving how much change can be enacted when resources are distributed adequately and governments actually slow down and listen to the needs of their people. It is okay not to have a perfect structure immediately, but this does not mean we should leave what

we have as it is. Whatever models Mayor Bass and former officials have put in place are simply not working, and we need to figure out how we can restructure what we have if we hope to make any difference on our current social issues.

Discussion & Conclusion

How We Can Actually Fix Things

To tackle poverty, we must increase the number of economic opportunities available to impoverished Angelenos while doing what we can to lower increasingly inflated costs of living. To increase job prospects (while ensuring that the wealth generated is concentrated in the communities that most need them), we should instate community development and investment programs by expanding public infrastructure, subsidizing locally-owned businesses, and introducing job placement and technical training programs. By expanding social welfare programs and relaxing the eligibility requirements for food assistance programs such as CalFresh, we can dramatically increase the purchasing power of people living in low-income neighborhoods, boosting consumption and growth for whole communities.

California should take Finland as an example and implement their ideas to solve the homeless issue. We can begin by mandating housing costs and increase the amount of temporary housing available for the homeless population. Additional regulations and support should be provided to homeless shelters to make them more approachable for the homeless people. For example, the homeless shelters need to be checked upon routinely to make sure they are hygienic and properly guarded to prevent any violence from going on inside or outside of the shelters. We need to make sure our shelters are actually safe for all types of people regardless of physical or mental ability, race, or gender identity. Providing safe shelters is the bare minimum the city of Los Angeles should be doing in order to actually help not just its homeless population, but all who hope to live in a clean and safe city.

Furthermore, extending the accessibility of affordable housing beyond just temporary shelters and living spaces is pivotal to provide assistance to individuals and families, who may find themselves homeless due to ridiculously high modern rent prices. Allocating more funds for affordable housing units and expanding programs tailored towards helping impoverished tenants pay their rent are all feasible solutions to tackle the source of homelessness.

Conclusion

If we continue to ignore this snowballing crisis, our community will gradually transform into landscapes of despair — tent cities beneath underpasses littered with heaps of old clothes, broken appliances, and cardboard boxes scattered throughout our city parks. The already overwhelmed homeless shelters will propagate disease outbreaks and violence, further endangering the unhoused and housed alike.

However, if we choose to turn a new leaf, we can imagine walking through a city where tenants are no longer pushed off the brink into homelessness. Picture a community where families don't have to spend a single night on the streets and where domestic violence survivors can seek refuge where they won't have to worry. A place where homeless shelters are empty — not because they are feared by the homeless but because the homeless have already begun leading new lives with homes, jobs, and families. This vision isn't just a fanciful hope — it's an achievable reality if we commit to addressing housing insecurity, and the crisis within the homeless shelters. Let us strive for a city where everybody has a place to call home.

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The Effect of Tank Size on an Aquaponics System using Blue Nile Tilapia's Output

Madison Miller

Abstract: Fertilizer runoff has been an issue for a while now, as it has been creating algal blooms. While there are many attempted solutions that have been helping, it is important to fine tune each solution to work the best. One of these solutions is aquaponics, and the effect of tank size is something that needs to be studied. In order to do this, two different tank sizes were used. One size was a 50 gallon, and the other was a 100 gallon tank. In each tank, the number of Blue Nile Tilapia was the same with both having 4 Tilapia in order to ensure that roughly the same amount of nutrients were put into the water. At the end of the experiment, it was clear that the smaller tank had the better growth results. This is because the height, in inches, and leaf length, in inches, was significantly bigger than the larger tank. So, when looking at the data, it was concluded that the 50 gallon tank with 4 tilapia worked the best. This infers that for this type of plant, a higher concentration of nutrients is ideal, and tanks using a similar setup in the future should ensure that the amount of water does not over-dilute the fish excrements.

1. Introduction

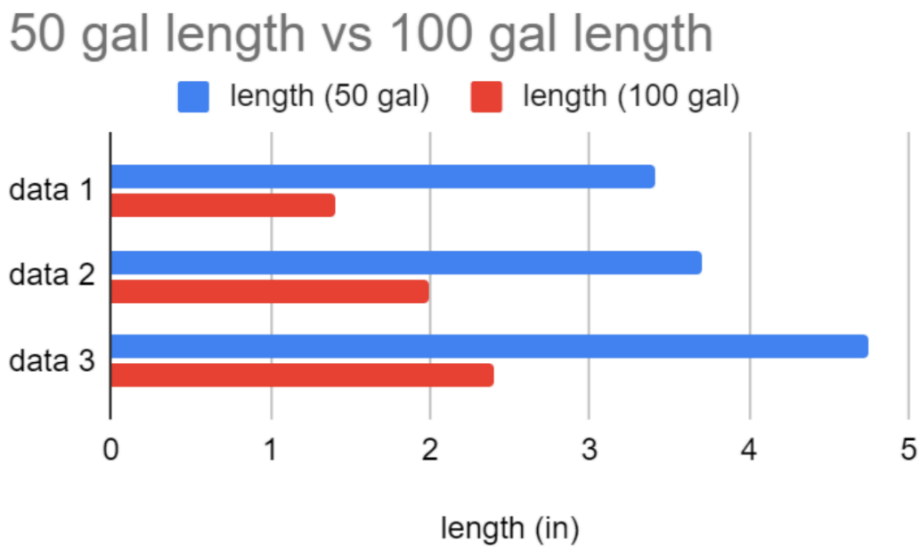
In order to be able to fully understand how to fix the problem of algal blooms, we need to understand each variable, such as nutrient density and plant species, and how it can work at its best. The issue with the blooms is that they take away necessary nutrients for an ecosystem. They deplete oxygen in the water, which not only harms plants but animals as well. When the components in an ecosystem suffer, the entirety of the ecosystem suffers with it. Algal blooms have typically been caused by fertilizer runoff, and aquaponics is a way to ensure that runoff would not be an issue. This is because there wouldn't be issues with the soil absorbing the nutrients, as there isn't any soil to worry about. Therefore, there isn't any concern about runoff. Not only that, the fertilizers are made naturally through the fish, so the ratio would be balanced enough to prevent algal blooms. Many people are familiar with the practice

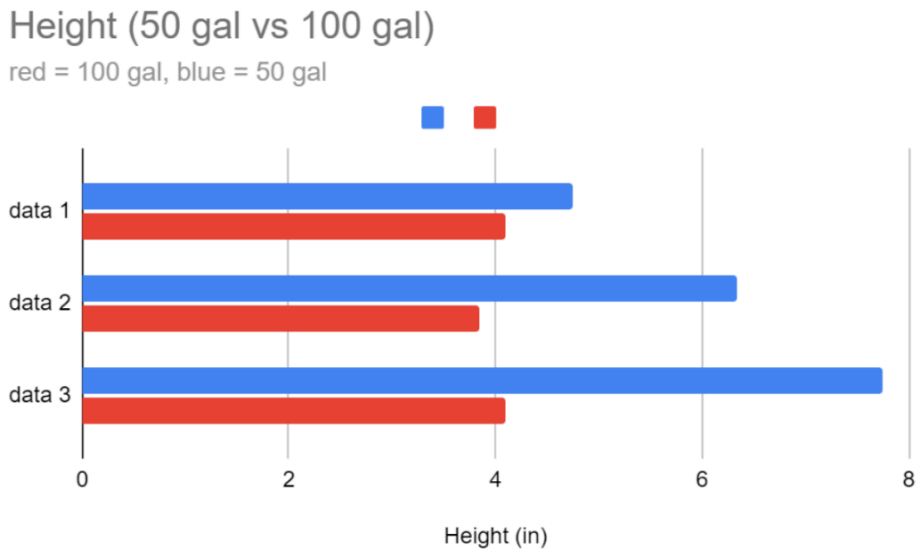
of generally growing plants in water, and Aquaponics is a relatively recent discovery. A researcher named Dr. James Rakocy was the first credited to experiment with different media beds in aquaponics. Typically, it works by setting up one tank that has live aquatic animals in it, typically fish, and using that water, because it has natural nutrients in it, to feed plants. Another benefit is that aquaponics has been seen to reduce "overall water consumption by 97% compared to traditional soil farming" (VMD Agro, n.d.). The purpose of this study is to determine how important the dilution of nutrients to the plants are, and whether it is better for the plants to have higher or lower concentrations. Although there have been studies on the hydraulic loading rate, and it was found that hydroponics "uses about 5 percent of the water and a fraction of the land needed to produce an equivalent amount of produce in traditional agriculture" , this study has not been able to find anything regarding the actual tank size (Alshrouf, n.d.). When doing this study, something that felt important was tank size, especially as the nutrient concentration is something that has been heavily studied in traditional agriculture. The reason why it is important to study this ratio is because "too much of any nutrient can inhibit the intake of other nutrients, resulting in deficiencies." (Hoidal & Rosen, 2021). The amount of water would change the concentration, and aquatic animals already give specific nutrients more than others. This only enhances the need for these studies, as if we want to use this method more in the future we need to understand all the components. Although not all nutrients were measured, the general nutrients such as ammonia, nitrites, and nitrates were measured. This does mean that many nutrients were unaccounted for. These nutrients do also bring the question of whether or not the plants in these aquaponic systems are getting enough nutrients to thrive. Some have looked into this, however, and said that the "presence of appropriate microbial assemblages reduces the need to add much of the supplemental nutrients that are routinely used in stand-alone hydroponic units" (Joyce, Goddek, Kotzen, & Wuertz, 2019). This study goes more into how nutrient cycling works effectively, however, yet again, it does not address the specific ratios that work best. Due to this, this study predicts that the higher concentrated nutrient tank will produce better results, however, this study does not measure more than two different concentrations, and it will be hard to determine the best concentration.

2. Methods and Materials

In order to determine whether a higher concentration or lower concentration of nutrients makes the plants grow better, two separate tanks were used. Although the actual type of tank and method for moving the water stayed the same, the tank size changed. Although there are different setups, this study used a bell siphon, which uses pressure and gravity to automatically drain a reservoir when the water level reaches a certain point. This setup allowed for a continual flow of water throughout the system, in which the tank of water containing the fish was on the bottom, and there were heaters and bubblers to keep the fish content. On the top of the system was

the rest of the water, and leca, or lightweight expanded clay aggregate, was chosen as the growing medium. As far as tank sizes, there was one 50 gallon tank and one 100 gallon tank. Included in this measurement was the amount of water that could be stored above with the leca part of the system. Everything was kept the same, so the only variable that was changed was the size of the tanks, which was the substrate tank and fish tank. There were 4 Blue Nile Tilapia in each tank, and they were fed the same amount at each feeding. One small cup full of food was used, and it measured out to be around ¾ of a cup. The fish were fed every other day from Monday to Friday. Before the data collection started, there had been a period of time that the fish were left to settle into their new environment and ensure that if anything went wrong, then it could be fixed before the data needed to be stable and consistent. This serves to also cycle the fish tank, which is something used when setting up traditional fish tanks that ensures the bacteria gets settled down in the tank. The cycling is important to ensure there aren't any large spikes in nutrients such as ammonia. This period lasted for around 4-5 weeks. The plants used were brassica oleracea, or kale. Aquaponics can be used for a large variety of plants, and works especially well with leafy greens. Kale was chosen due to its accurate representation of the average plants that would benefit from this growing method. The plants started off being grown inside, and the plants that were chosen were all identical in height originally, only being around an inch tall. When the plants were put in, they were all spaced around 8 inches from each other, the same amount of plants in each tank. There were 6 plants in each. The data collected was taken over the span of 3 weeks, one measurement per week, at the end of the week. When these measurements of the plant's height and leaf's weight were taken, there were also measurements about the ammonia, nitrate, and nitrites taken. This was done through a freshwater testing kit, which used different chemicals to change the color of the water based on any contaminants present. The specific materials used was the API freshwater testing kit. The measurements for the plants were done traditionally, simply measuring from the base of the plant to the top or from the base of the leaf to the tip using a ruler in inches. Each plant was measured, and then the average was taken for each tank to simplify the results.





3. Results

The final results from this experiment showed that the tank that had a higher concentration of nutrients, which was the smaller tank, gave better results than the tank that had a lower concentration of nutrients, which was the larger tank. When the plants started out, the plant height was similar, with only half an inch in difference. However, as the experiment progressed, the difference grew dramatically. By the end of the experiment, there was around 4 inches in difference, with the taller plants belonging to the smaller 50 gallon tank. While this may be the case for the height, the leaf size was constantly different during the experiment. From the beginning, the 50 gallon tank had around 2 inches of a difference. By the end, it was still around 2 inches of a difference, with both tanks

growing their length around the same amount. At the end, the average height of the 50 gallon was 7.75 in while the leaf width was 4.75 in. In comparison, the average height of the 100 gallon was 4.1 in with the leaf width being 2.4 in. As far as the nitrates, nitrites, and ammonia goes, they stayed stable throughout the experiment. For the most part, they stayed at 0 ppm with only slight deviations to less than .25 ppm.

4. Discussion

Although this experiment is able to showcase how effective aquaponics is, it also shows that there are many things that need to be fine tuned in order to use this growing method to its fullest potential. During this experiment, it was shown that the higher concentrated tank produced better results with different enough results to matter. These results support the hypothesis that the higher concentrated nutrient tank will produce better results. The height in the 50 gallon was nearly double the height of the 100 gallon, and this is a major difference. While it has been acknowledged that the leaf length isn't as large of a difference, it is still enough to be noticeable. This allows for future researchers to focus less on what specific concentration is necessary if they are doing a general study on aquaponics, and they can simply know that using more fish is more beneficial, as it will result in a higher concentration and better results. The original large scale problem presented was the issue of algal blooms due to fertilizer run-off. Despite this experiment being on a smaller scale, it can help show that when using a larger setup, aquaponics is fully capable of growing large quantities of plants without the issue of runoff. Unlike with traditional growing methods, if any water from this system spills there would not be large amounts of excess nutrients going into nearby water sources. This is because the nutrient amount already matches what is typically needed for fish to do well, and there is not anything artificially added, which is how it would be in traditional farming. As long as the nutrients are balanced and measured throughout the experiment, there also isn't a high likelihood of creating algal blooms accidentally in the fish tanks. During this experiment there were issues with the setup of the tanks as occasionally the growing medium would get stuck in the pipes causing the water flow to stop or the pipes would leak, and this could have affected the results. This also could be an issue with the style of aquaponics used, as the bell siphon system often had trouble trying to keep the water flow and not get extra substrate stuck. Although it might not have made a large difference because it is not as if during this process a water change was done, this occurrence would still disrupt the natural growth of the plants. This is the reason that it is important to make sure everything is running well before the experiment, which is what the 4-5 week period was for. Not only that, it could also provide extra inspiration in more experiments that can be done in order to determine the easiest system to use for larger scale areas. If the same issues are prevalent in all systems that use this setup, it would only be more difficult to make use of aquaponics on full-scale farms. The time used for this system may not work for another system, as it depends on what is in

the tank itself. If there are any plants in the tank, those need to be accounted for when determining the ideal amount of time. In addition, it is difficult to compare these results as there were only two tanks, however, the results do show that it is better to have higher concentrations than lower concentrations. This way in future experiments, they will not have too little nutrients for the plants. However, this can also vary per plant so this information is mainly applicable for brassica oleracea. This suggests that there are many possibilities for future experiments, as there could be experiments dedicated simply to one plant type and finding the perfect ratio. Not only that, there could also be experiments dedicated to measuring what other elements should be added to these tanks to maximize the variety of nutrients being given to plants. Aquaponics is a field that should be studied more, as it has the potential to not only help conserve water, but also conserve ecosystems while still growing necessary crops.

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