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The Impact of Digitalization on Manufacturing Firms' Competitiveness, Environmental Sustainability, and Social Inclusiveness

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ABSTRACT

Manufacturing is a crucial driver of economic growth, contributing approximately 17% to global GDP. This research investigates the impact of digitalization on manufacturing firms' competitiveness, environmental sustainability, and social inclusiveness, using Canon Inc.'s operations globally as a case study. Existing literature underscores the transformative potential of digital economics in the manufacturing industry; however, a comprehensive exploration of its impact on sustainability remains to be explored in detail. Employing a mixed-methods approach and Systems Theory as a theoretical framework, data was gathered from Canon's sustainability reports, financial statements, and online sources, focusing on the years 1997 to 2018. The study analyzes the implementation of digital technologies and their effects on profitability and sustainability outcomes. The research results indicate positive results with sustainable firms able to beat the competition in the long-run, as demonstrated by Canon's revenue of approximately $36 billion in 2018 alongside significant reductions in CO2 emissions by 435,000 tonnes and a reduction in raw material usage by 314,000 tonnes. Additionally, Canon's social initiatives, such as the Miraisha Programme, underscore its commitment to inclusivity. This study highlights the multifaceted benefits of integrating digital technologies in manufacturing, offering insights for firms aiming to balance profitability with sustainability.

Keywords: Digitalization, Manufacturing, Competitiveness, Environmental Sustainability, Social Inclusivity, Systems Theory

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INTRODUCTION

Industrialization is often viewed as a transformative period that introduced remarkable inventions and engineering feats, fundamentally changing societies and economies across the globe. It harnessed the power of machines, leading to increased productivity and the rise of urban centers, akin to a new "wonder of the world" due to its significant impact on human life (Nuraini et al., 2024). However, industrialization was a double-edged sword, at least in hindsight today. Although it was essential to the growth of today's developed countries, the widespread use of manufacturing technologies and machines led to an existential crisis of global warming.

The impact of climate change can be categorized into natural consequences such as high temperatures, droughts, and wildfires; floods; social consequences such as health and education; and business consequences such as supply chain disruptions and access to natural resources (The Directorate-General for Climate Action, EU, 2024). The interplay between these categories creates a vicious cycle, compounding the crisis.

Increasing global competition, in addition to environmental concerns, has pushed firms to continuously innovate and improve their operations to remain competitive and meet evolving market demands (Zhu et al., 2023; Efawati et al., 2021, Chaniago, 2022). Over the last century, manufacturing companies have adopted various methodologies such as Taylor's scientific management, lean manufacturing, material requirements planning (MRP), and enterprise resource planning (ERP) to streamline operations. More recently, Industry 4.0 technologies have gained traction, offering advanced IT solutions that enhance competitiveness and operational efficiency (Liao et al., 2017, Chaniago & Efawati, 2024). These technologies are viewed as key drivers of competitive advantage, prompting governments worldwide to focus on industrial digitalization.

Earlier research highlights how digitalization improves manufacturing processes, creating fully integrated, automated, and optimized production systems. This brings numerous benefits, such as increased productivity, revenue growth, enhanced employment, and investment opportunities (Rüßmann et al., 2015, Thariq & Efawati, 2024). Digitalization can also unlock the potential for green manufacturing through more accurate data collection, real-time event management, and resource efficiency (Jabbour et al., 2018). Technologies like virtual and augmented reality (VR/AR) can further reduce environmental impact by enabling prototyping at the design stage without the need for physical resources (Chang et al., 2017).

Despite this extensive research on digitalization's benefits for competitiveness and environmental sustainability, there has been little focus on its simultaneous impact on firms' competitiveness, environmental sustainability, and social inclusiveness. This study aims to address this gap, exploring how digital transformation can influence all three dimensions in the manufacturing sector. Digital technologies are reshaping industries, offering opportunities to enhance the competitiveness of manufacturing firms, reduce environmental footprints, and promote social inclusiveness. Digitalization, when aligned with sustainability goals, has the potential to decouple economic growth from environmental degradation, driving the transition toward a circular economy and greener manufacturing processes.

Canon Inc., a prominent global manufacturer and a leader in imaging and optical products, presents an ideal case for examining the impact of digitalization on competitiveness and sustainability. As a multinational corporation with a significant environmental footprint and a longstanding commitment to innovation, Canon faces the dual pressures of reducing its ecological impact while maintaining a competitive edge in

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a rapidly digitalizing industry. Given the urgency of addressing climate change and the increasing demand for sustainable practices, analyzing Canon's strategies provides valuable insights into how large manufacturers can effectively integrate digital technologies to drive sustainability and inclusivity (Efawati & Chaniago, 2017). This case study is particularly timely, as it highlights the urgent need for manufacturing firms worldwide to adopt digital solutions to meet both regulatory standards and societal expectations for sustainability (Porter & Kramer, 2019).

LITERATURE REVIEW

Systems Theory

Systems Theory provides a holistic framework for analyzing the interconnected impacts of digitalization on manufacturing firms. Originating from the work of (Bertalanffy, 1969), this theory views organizations as complex systems with interdependent components, where changes in one area influence others.

This study conceptualizes the company as an open feedback-controlled system, continuously interacting with its environment and adapting to align outputs with desired outcomes. Digitalization plays a central role in enhancing this system's adaptability by enabling real-time data collection, analysis, and control. Through feedback loops, the company can dynamically adjust its strategies and operational processes to remain competitive while minimizing environmental impact and addressing social expectations. Within this model, the company comprises two primary subsystems: a 'management' subsystem and a 'transformation' subsystem, both of which are integral to leveraging digital transformation effectively.

The management subsystem focuses on decision-making processes, including planning, strategy development, monitoring, and control, now increasingly supported by digital tools and data analytics. These digital enhancements enable faster and more informed decision-making, helping management align company actions with internal goals and external requirements, such as regulatory standards and stakeholder expectations. In particular, digitalization facilitates the development of business strategies that balance economic objectives with environmental and social priorities, making it an essential tool for sustainable competitiveness.

The transformation subsystem is where digitalization directly impacts value creation. This subsystem draws on material inputs such as raw materials and energy and nonmaterial inputs, including data and information, to produce outputs. With digital technologies, these transformation processes can be optimized to improve efficiency, reduce waste, and lower greenhouse gas emissions. This system generates both desirable outputs, such as innovative products, services, and a positive public image, and unintended byproducts, such as emissions and waste, which are minimized through digital monitoring and control. Furthermore, the company's interactions with various stakeholderscustomers, suppliers, regulators, and community groups are mediated by digital platforms that enhance transparency and foster trust.

Digitalization and Manufacturing

The intersection of digitalization and manufacturing has garnered significant attention in recent years, especially as industries adapt to technological advancements. Digitalization refers to the wide-ranging sociotechnical processes and phenomena involved in adopting and utilizing digital technologies across individual, organizational, and societal levels (Legner et al., 2017). Digital transformation in manufacturing encompasses the integration of advanced technologies such as the Internet of Things (IoT), artificial

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intelligence (AI), and big data analytics into production processes. According to Porter and Heppelmann (2017), smart, connected products are reshaping competition and driving value creation in manufacturing. This integration facilitates real-time data collection and analysis, allowing firms to optimize operations and improve decision-making.

Industry 4.0, also known as the fourth industrial revolution, represents a new era of industrial organization and control over the value chain throughout the product life cycle. Its focus is on addressing increasingly personalized customer demands, affecting areas such as order management, research and development, production, commissioning, delivery, and even product utilization and recycling (Rüßmann et al., 2015; Neugebauer et al., 2016). Recent studies indicate that digitalization enhances operational efficiency and productivity. For instance, a study by Kamble et al. (2020) found that implementing Industry 4.0 technologies led to a significant reduction in lead times and operational costs. Furthermore, digitalization supports more agile supply chains, which are crucial in today's fast-paced market environment (Lie et al., 2022).

Environmental Sustainability

Environmental sustainability within the context of Industry 4.0 has garnered considerable attention in existing literature. However, there is no clear consensus on whether Industry 4.0 will have a long-term positive effect on environmental sustainability. While some argue that digital technologies can contribute to greener production processes, others highlight the environmental costs of digitalization. Research by Martínez-Peláez et al. (2023) demonstrates that the adoption of digital technologies can lead to substantial reductions in resource consumption and waste generation.

For example, IoT-enabled systems allow for precise monitoring of energy use and emissions, facilitating more sustainable production practices (Okot et al., 2023). However, critics point out that digital technologies increase resource consumption, energy usage, and waste production (J.Olah et al., 2020). Moreover, digitalized manufacturing processes are more energy-intensive, requiring significant electricity to power data centers and their associated networks (Cosar, 2019).

Social Inclusiveness

Social inclusiveness within manufacturing, particularly in the context of digitalization, is an emerging area of interest. Research indicates that technology adoption can improve workforce skills and promote inclusivity. For instance, the Miraisha Programme by Canon focuses on enhancing employability for youth in Africa through training in imaging technology, thereby fostering social responsibility and community development (Canon, 2022). Studies highlight the importance of corporate social responsibility (CSR) in enhancing brand reputation and customer loyalty (Zainon et al.,2023). Digital tools can enhance transparency in CSR initiatives, enabling firms to engage stakeholders more effectively and demonstrate their commitment to social goals (Liu et al., 2023).

RESEARCH METHOD

This research aimed to study and investigate the link between digital economics and improved sustainability in Canon's manufacturing processes and answers the question: How the introduction of various digital technologies in the manufacturing processes of Canon not only helped it in its overall profitability but also contributed to the sustainability of business and the environment it is working in? To do that, mixed-methods research methodology with Systems Theory as a theoretical framework was used

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with a case study approach. For qualitative data, we gathered information from previous research studies and literature reviews, published financial and sustainability reports and other relevant data from website of Canon. For quantitative analysis to measure the before and after profitability and impact measurement of Canon's various initiatives on its business and environment, we use time-series data analysis for the identification of trend in our desired data set. We gather data from Canon Inc.'s consolidated financial statement from 1997 to 2018 to analyze its financial performance.

To measure the impact of adoption of digital economics by Canon in its operations, we use three dimensions of firm's performance: competitiveness, environmental sustainability and social inclusiveness. Competitiveness is the firms ability to take maximum benefit from factors of external environment and core competencies from its internal resources (Milusheva, 2020). Environmental sustainability means maintaining natural capital, protecting sources of raw material and limiting wastes. Social inclusiveness is the process of "improving the ability, opportunity, and worthiness of people, disadvantaged on the basis of their identity, to take part in society" (World Bank, 2013).

Since we took data from the consolidated financial statements of Canon, we assumed in our research that Canon gives equal importance to all of its global operations, irrespective of their performance in revenues. This assumption could potentially introduce biases, as it may not accurately reflect the company's strategic focus or resource allocation across different regions. However, considering that sustainability is a global issue and that Canon is a global manufacturer, its initiatives are likely to be implemented on a global scale.

The company cannot survive without addressing sustainability across all markets, as consumer expectations and regulatory pressures demand consistent, eco-friendly practices. Future research could improve upon this by conducting a more granular analysis of Canon's operations, examining regional performance metrics and strategic priorities. This would provide a clearer picture of how different markets are prioritized and how that impacts overall competitiveness and sustainability efforts. Additionally, including qualitative insights from regional managers or stakeholders could further enhance understanding of Canon's operational dynamics.

RESEARCH RESULTS

To study the the competitiveness of Canon's manufacturing, we take its profitability as competitive firms are able to remain profitable even in challenging times. As we can see in Figure 1 below, Canon has had relatively linear sales growth from 1997 to 2018. Its revenue for the year 1997 was $27 billion. By the end of the year 2018 its revenue reached $35.93 billion. It is important to note that Canon, being a camera manufacturer in its roots, has not only been able to survive but has been operating profitably, despite facing stiff competition arising from the emergence of mobile phone cameras. This demonstrates that Canon's swift adoption of digital technologies has helped it produce innovative, customer-centered products, which in turn has made it possible for it successfully navigate stiff competition for over two decades.

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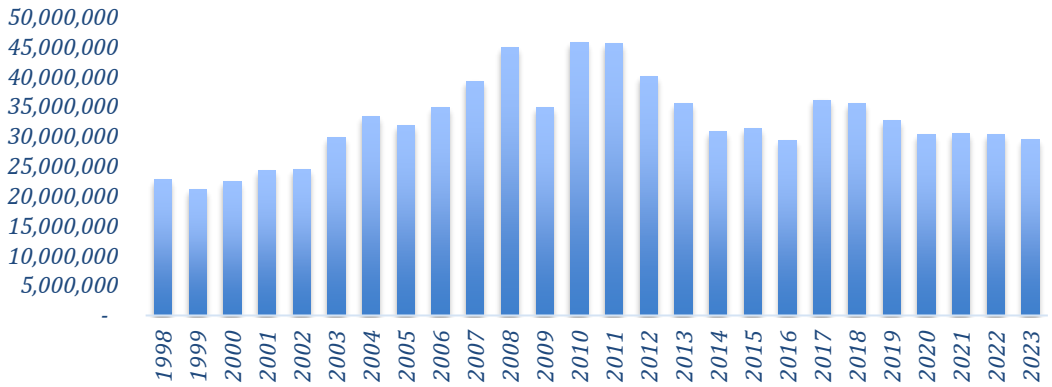

Figure 1. Canon's Annual Revenue (in thousands $)
Source: Own Compilation

With respect to environmental dimension, Canon has been actively involved in environmental initiatives from 2008 to 2022, resulting in significant positive outcomes. Notably, the company has successfully saved over 435,000 tonnes of CO2 emissions. In terms of recycling efforts, approximately 444,000 tons of toner cartridges have been recycled at four key sites, spanning Japan, the United States, Europe, and China. Canon has also achieved a cumulative reduction in the use of new resources, totaling around 314,000 tons.

Through their commitment to sustainability, they have taken 42,413 tons of plastics from used products for recycling as raw materials, and an additional 33,619 tons of products and parts have been reused directly. Canon places a strong emphasis on the strict management of chemical substances. Looking ahead, the company has set a commendable goal to achieve net-zero CO2 emissions by the year 2050, showcasing their dedication to environmental responsibility and sustainability.

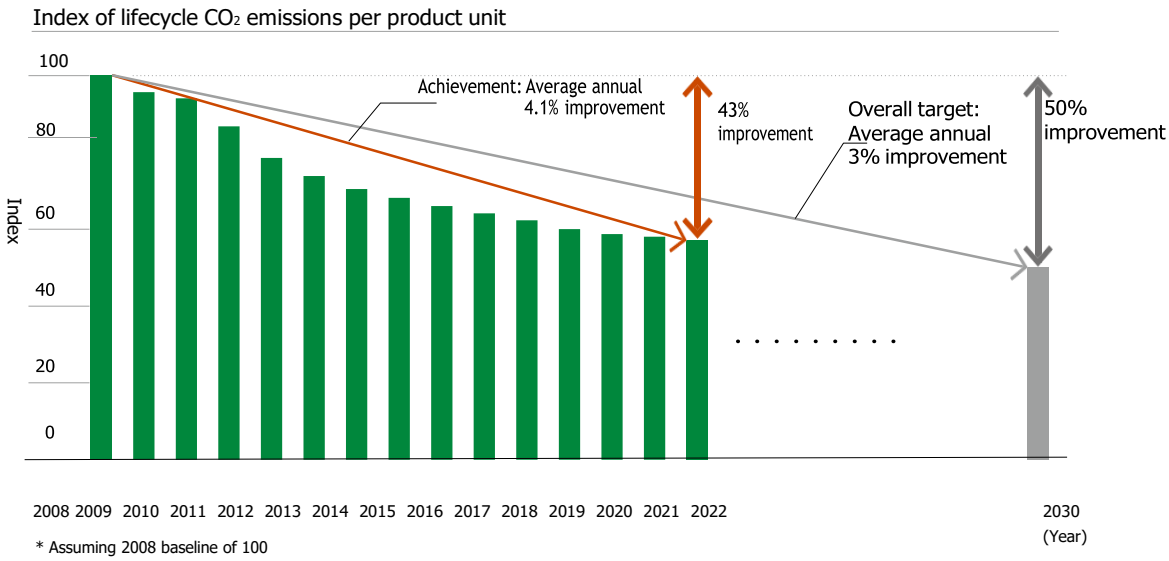

Figure 2. Canon's CO_2 Emissions Product Unit Index
Source: *Canon Inc.,2023*

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With respect to social dimension, Canon is actively engaged in various social initiatives to make a positive impact on communities. One such initiative is the Canon Bird Branch Project, where the company promotes diverse activities centered around the theme of birds at its locations in Japan and abroad. Additionally, Canon is committed to upholding human rights through a diligent process that involves assessing human rights risks in workplaces. This assessment is conducted with the assistance of external experts, and the Responsible Business Alliance's Self-Assessment Questionnaire (RBA's SAQ) is used to evaluate risks within the supply chain. Another significant social investment initiative by Canon is the Miraisha Programme, which operates in Africa.

The primary goal of this program is to foster employment opportunities and enhance the skills of young workers in fields such as photography, video, and printing. Canon achieves this through workshops and a comprehensive guidance program. Furthermore, Canon leverages its extensive experience in imaging technology to contribute to sustainable agriculture. In response to environmental changes driven by factors like climate change, Canon has developed the GM-1 crop growth monitoring system. This nondestructive and non-contact tool utilizes images of crops to automatically assess growth metrics. The GM-1 system combines Canon's unique image analysis technology, tailored to crop characteristics, with AI diagnostic technology based on deep learning. Through these initiatives, Canon demonstrates its commitment to social responsibility and sustainability.

DISCUSSION

In this section, we examine a range of digital production technologies that have significantly contributed to Canon's performance across three key dimensions: competitiveness, environmental sustainability, and social inclusiveness. By leveraging these advanced technologies, Canon has not only enhanced its operational efficiency but also positioned itself as a leader in addressing contemporary challenges in the manufacturing sector. This discussion will explore how these innovations have enabled Canon to navigate a rapidly evolving market while fostering a commitment to sustainable practices and social responsibility. The interconnectedness of technological advancements and their broader societal impacts exemplifies the principles of Systems Theory, which emphasizes the holistic interactions among organizational components.

As organizations face different types of risks and opportunities around the world (Cao et al.,2021), an important consideration in assessing Canon's strategies is whether its actions are consistent across developed and developing countries. While advanced technologies and sustainability initiatives may be more readily implemented in developed markets due to better infrastructure and resources, the challenges in developing regions may necessitate different approaches.

For instance, in developing countries, Canon might focus more on establishing local partnerships, enhancing accessibility, and adapting technologies to meet specific market needs. This disparity underscores the relevance of Systems Theory, as it highlights how organizations must navigate diverse contexts and stakeholder expectations (Meadows, 2008). The varying regulatory environments and consumer behaviors in these regions can significantly influence the effectiveness of Canon's initiatives. Understanding these dynamics is crucial for optimizing Canon's strategies to achieve sustainable impact in varied socio-economic environments.

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Advanced Production Technologies: Canon's strategic implementation of advanced manufacturing technologies is pivotal for creating cost-effective and competitive products. By leveraging robotics, machine vision, artificial intelligence, and the Internet of Things (IoT), Canon has significantly streamlined its assembly processes and lowered production costs. This transformation showcases Systems Theory's concept that organizations function as dynamic systems, where the integration of technology catalyzes efficiency and innovation across various processes. A prime illustration of this is Canon's innovative automated system for toner cartridge production, which exemplifies how continuous, uninterrupted production lines can enhance product quality while simultaneously reducing expenses. This integration of digital technologies not only drives productivity but also empowers Canon to deliver innovative, customer-centric products, thereby strengthening its competitive advantage in the market, reflecting the systemic value creation that occurs when technology and organizational strategy align.

To achieve operational excellence, Canon emphasizes the importance of automation across its product designs. This focus enables the company to efficiently manage increasingly complex assembly tasks, mirroring Systems Theory's idea of interdependence among components within a system. Canon's automated systems encompass every stage of toner cartridge production, from component machining to assembly, inspection, packing, and recycling. The aim of this robust automation system is to establish a seamless production line that operates continuously, ensuring superior quality while minimizing costs. The production equipment utilized in this process was developed through close collaboration between Canon's Product Development teams and advanced technologies, including 3D-CAD, analytical simulation, and virtual reality. These innovations draw on Canon's proprietary manufacturing technologies, extending their application beyond toner cartridges to include a wide array of products such as single-lens reflex (SLR) cameras, mirrorless cameras, and interchangeable lenses.

Looking forward, Canon anticipates that these advancements will continue to drive cost reductions while enhancing overall product quality, further solidifying its position as a leader in the manufacturing sector. This proactive adaptation to technological change aligns with Systems Theory, which stresses the need for organizations to evolve in response to their environments.

Digital Business Platform: The establishment of Canon's Digital Business Platform has been a transformative initiative, fostering enhanced connectivity between its physical products and cloud-based services. By harnessing the power of cloud technologies and advanced data analytics, Canon has significantly improved customer experiences and operational efficiencies. This platform serves as a critical nexus, integrating various organizational elements and enhancing overall system functionality, a key principle of Systems Theory. This platform serves as the backbone of Canon's service offerings, enabling the seamless integration of hardware with digital capabilities.

Through this innovative platform, Canon is able to provide intelligent services that enhance the functionality and reliability of its products. For instance, customers benefit from features that ensure consistent performance, thereby fostering loyalty in an increasingly competitive market. This approach not only adds value to Canon's offerings but also reinforces the company's commitment to customer satisfaction, which is critical for maintaining its competitive edge amid rapid technological advancements.

The Digital Business Platform also supports Canon's initiatives in data analytics, allowing the company to gather insights from product usage and customer interactions. This data-driven approach embodies the systemic feedback loops described in Systems Theory, enabling Canon to adapt its offerings based on real-time customer needs. This

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data-driven approach enables Canon to anticipate customer needs more effectively and tailor its services accordingly. By bridging the gap between physical and digital realms, Canon is not only enhancing the user experience but also positioning itself as a forward-thinking leader in the manufacturing industry. As Canon continues to refine and expand its Digital Business Platform, it remains committed to leveraging these technologies to drive innovation and create lasting value for its customers. This strategic focus on digital integration illustrates Canon's proactive stance in adapting to market changes while reinforcing its competitive position in the industry.

Uniflow Online Hybrid Work Technology: The introduction of uniFLOW Online has been a pivotal response to the evolving needs of businesses, particularly in light of the rise of hybrid work environments accelerated by the COVID-19 pandemic. This innovative cloud-based print management solution allows organizations to effectively manage print jobs and secure sensitive information, facilitating a seamless transition between remote and in-office work. This adaptability exemplifies Systems Theory's principle of responding to external pressures within a complex system. UniFLOW Online enables employees to authorize print jobs using their unique ID cards, streamlining the process while ensuring robust data collection. This functionality not only enhances operational efficiency but also allows organizations to maintain visibility over printing activities, which is critical for managing costs and ensuring information security.

The service supports cloud storage solutions, enabling users to save documents for printing later, thus providing flexibility and convenience in accessing printed materials from various locations. Canon's commitment to enhancing this technology aligns with the increasing demands for security and adaptability in the workplace. The development of the Hybrid Work Print Standard, which integrates with consumer-oriented printers commonly used at home, further showcases Canon's agility in addressing contemporary workplace challenges.

This feature allows organizations to monitor printing metrics, such as the total number of pages printed and file names, thereby mitigating risks associated with data breaches and promoting responsible printing practices. Through uniFLOW Online, Canon demonstrates its dedication to empowering businesses to navigate the complexities of modern work environments. By providing a comprehensive solution that combines print management with enhanced security, Canon not only meets the current needs of its customers but also strengthens its position as a leader in workplace technology.

Big Data For Increased Customer Value: Canon's strategic utilization of big data analytics is transforming its ability to deliver exceptional value to customers, significantly enhancing operational efficiency and satisfaction. By harnessing real-time data, Canon has developed innovative solutions that streamline processes and proactively address customer needs. A prime example of this is Canon's automated toner supply system, which leverages data from networked office multifunction devices to monitor toner levels.

This proactive approach ensures that customers never run out of supplies, maintaining optimal productivity in their operations. By predicting resource requirements based on actual usage patterns, Canon not only minimizes downtime but also enhances overall customer satisfaction, solidifying its reputation as a reliable partner in the industry. Moreover, Canon employs big data analytics to gather insights from various consumable items, such as printer drums and other components. This systematic analysis allows Canon to implement a precise replacement service, optimizing the lifespan of these parts and ensuring that customers receive timely maintenance.

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The ability to analyze sensor data from different products further illustrates Systems Theory's emphasis on feedback mechanisms, enabling Canon to identify potential issues before they escalate. The ability to analyze sensor data from different products further enables Canon to identify potential issues before they escalate, providing customers with the peace of mind that their equipment will operate seamlessly. This data-driven approach is not only about efficiency; it is also about enhancing the overall customer experience.

By understanding usage patterns and preferences, Canon can tailor its services and offerings to better meet the specific needs of its clients. This level of personalization fosters deeper customer relationships and reinforces Canon's position as an industry leader committed to delivering value through innovative solutions. In summary, Canon's strategic use of big data analytics significantly enhances its capacity to provide value to customers. By ensuring resource availability, optimizing maintenance, and personalizing services, Canon demonstrates its commitment to leveraging technology for the benefit of its clients, thus solidifying its competitive advantage in the market.

Green Platform: Canon's Green Platform embodies the company's steadfast commitment to environmental sustainability, integrating eco-friendly practices across its entire product lifecycle. This comprehensive framework not only addresses growing societal concerns about environmental impact but also positions Canon as a leader in sustainable manufacturing. By viewing sustainability through the lens of Systems Theory, Canon recognizes that its environmental efforts are interconnected with its operational practices and societal expectations. The Green Platform consolidates various technologies and initiatives aimed at minimizing Canon's ecological footprint. By focusing on resource conservation, energy efficiency, and product reuse and recycling, Canon demonstrates its proactive stance in tackling environmental challenges. The platform encompasses strategies that enhance operational practices, ensuring that sustainability is a core principle in every phase of production.

One of the standout features of Canon's Green Platform is its ambitious recycling initiatives. Over the years, Canon has successfully recycled more than 444,000 tonnes of toner cartridges across its facilities in Japan, the United States, Europe, and China. This commitment not only reduces waste but also supports the circular economy by reclaiming valuable materials for reuse. Canon's focus on the entire product lifecycle, from design to disposal, showcases its dedication to sustainable practices. Furthermore, Canon has set a commendable goal of achieving net-zero CO2 emissions by 2050. This ambitious target highlights the company's long-term vision for sustainability and reflects its commitment to reducing its environmental impact. By leveraging advanced manufacturing technologies, Canon continuously works to enhance resource efficiency, thereby minimizing energy consumption and waste generation in its operations, thus embodying Systems Theory's notion that sustainable practices can lead to systemic improvement.

The Green Platform also incorporates the principles of the Circular Economy, which are vital for achieving sustainable development. Canon's initiatives include designing products with recyclability in mind, implementing repair and reuse strategies, and innovating processes to minimize the use of harmful materials. These efforts not only contribute to environmental preservation but also align with consumer expectations for responsible business practices. In conclusion, Canon's Green Platform stands as a testament to its dedication to environmental sustainability. By integrating eco-friendly technologies and practices into its operations, Canon not only enhances its corporate responsibility profile but also sets a benchmark for others in the manufacturing sector. This holistic approach to sustainability underscores Canon's commitment to balancing

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profitability with ecological stewardship, ultimately contributing to a more sustainable future.

Circular Economy Initiatives: Canon's Circular Economy Initiatives represent a pivotal aspect of its commitment to sustainability and resource efficiency. By establishing robust recycling and reuse systems, Canon seeks to minimize waste and extend the lifecycle of its products, thereby aligning with global efforts to create a more sustainable economy. A cornerstone of these initiatives is the establishment of five recycling centers strategically located in Japan, North America, Europe, and China. These centers play a crucial role in enhancing resource efficiency by implementing comprehensive systems for the collection, recycling, and repurposing of products at the end of their lifecycle.

Notably, Canon's long-standing toner cartridge recycling program, initiated in 1990, has successfully processed an impressive volume of spent cartridges. If laid end-to-end, the length of these recycled cartridges would circle the Earth four times, illustrating Canon's substantial impact on waste reduction. This initiative highlights Systems Theory's emphasis on the interconnectedness of resource management and ecological impact, demonstrating how Canon's actions contribute to broader sustainability goals.

The Canon Eco Technology Park, launched in 2018, further underscores the company’s dedication to innovation in recycling processes. This facility utilizes cutting-edge automated systems to enhance recycling efficiency, specifically for toner cartridges. By employing advanced separation techniques, Canon achieves a remarkable sorting purity of 99% or higher for the recovered materials, such as high-impact polystyrene (HIPS). This not only reduces the volume of waste sent to landfills but also reintroduces valuable resources back into the production cycle.

In addition to recycling, Canon emphasizes "remanufacturing" as a key strategy. Since 1992, the company has been restoring old multifunction devices to like-new condition, thus extending their usable life. This process embodies Systems Theory’s principle of sustainability through lifecycle management, ensuring that products are designed to be durable and recoverable. This process involves meticulous disassembly, inspection, and refurbishment, ensuring that high-quality standards are maintained. By creating products that are highly sortable and durable, Canon has achieved a reused parts ratio exceeding 90% in its latest models, showcasing its commitment to sustainable product design.

Canon's Circular Economy initiatives also prioritize energy efficiency and resource conservation throughout the entire product lifecycle. The company actively engages in product lifecycle decarbonization, focusing on minimizing CO2 emissions from material acquisition to recycling. By optimizing manufacturing processes and reducing waste generation, Canon enhances its operational efficiency while mitigating its environmental impact.

Product Lifecycle Decarbonization: Canon's commitment to Product Lifecycle Decarbonization underscores its proactive approach to minimizing carbon emissions across every stage of its products' lifecycles. This initiative encompasses a comprehensive strategy that addresses environmental impact from material acquisition through manufacturing, distribution, usage, and ultimately recycling. Systems Theory informs this approach by highlighting the importance of examining the entire system recognizing how changes in one area can affect the overall environmental impact. At the design phase, Canon employs advanced simulation technologies to optimize resource utilization and energy conservation. By meticulously assessing the environmental footprint during

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product development, Canon strives to mitigate resource consumption and enhance transportation efficiency.

This meticulous approach ensures that products are designed not only for performance but also for sustainability, reducing their overall carbon footprint. Canon's innovative efforts extend to the operational phase of its products. The company is developing sophisticated systems to monitor and analyze energy consumption in real-time across its manufacturing processes. This granularity allows Canon to identify inefficiencies and implement targeted improvements, effectively reducing energy waste. By disaggregating industrial power use, Canon can pinpoint specific areas for enhancement, leading to more sustainable production practices.

Additionally, Canon's focus on reducing the size and weight of its products contributes significantly to lowering emissions during transportation. By optimizing the design to achieve compactness without sacrificing functionality, Canon minimizes the energy required for distribution, further decreasing its environmental impact. Throughout the product lifecycle, Canon emphasizes a circular approach to decarbonization. By integrating recycling and resource recovery into its processes, the company ensures that materials are reused, thus lessening the need for new resource extraction and production. This commitment aligns with Systems Theory's assertion that sustainable practices must be systemic, addressing interrelated factors across the product lifecycle.

Contribution to Academic and Theoretical Discourse

This research makes significant contributions to the academic discourse surrounding digitalization in manufacturing, particularly through the lens of Systems Theory and Sustainability Theory. By examining Canon Inc.'s strategic implementation of digital production technologies, this study demonstrates how these innovations not only enhance competitiveness but also promote environmental sustainability and social inclusiveness.

Firstly, the findings contribute to Systems Theory by illustrating the interconnectedness of various organizational components technology, operations, and sustainability practices. This research demonstrates that effective integration of digital technologies within manufacturing processes does not occur in isolation; rather, it requires a holistic approach that considers the impact on the environment and society. By documenting Canon's practices, the study provides empirical evidence that supports the idea that organizations must evolve as integrated systems to thrive in contemporary markets.

Furthermore, this research clarifies the importance of sustainability within the manufacturing sector. It highlights how Canon's initiatives, such as its Green Platform and Circular Economy practices, not only align with global sustainability goals but also enhance the company's competitive position. This dual focus underscores the notion that sustainability is not merely a regulatory obligation but a strategic imperative that can drive innovation and customer loyalty. By connecting sustainability with competitiveness, this study contributes to the growing body of literature advocating for a paradigm shift in how manufacturing firms approach their operations.

CONCLUSION

This research paper examined the impact of digitalization on manufacturing firms, with a specific focus on Canon Inc., in relation to competitiveness, environmental sustainability, and social inclusiveness. Through a comprehensive analysis utilizing a mixed-method approach and the systems theory as a theoretical framework, including

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data from Canon's financial and sustainability reports, we provided insights into how digital transformation has shaped the company's performance over time.

The findings indicate that Canon's strategic adoption of advanced manufacturing technologies such as robotics, machine vision, artificial intelligence, and the Internet of Things has significantly enhanced its operational efficiency and product quality. This has enabled the company to maintain a steady revenue growth trajectory, achieving approximately $35.93 billion in 2018 despite increasing competition from mobile technology. Moreover, Canon's digital initiatives, particularly its Digital Business Platform and uniFLOW Online Hybrid Work Technology, have not only improved customer experiences but also allowed the company to adapt swiftly to the evolving market demands.

The effective use of big data analytics has further strengthened Canon's capability to deliver value to customers while minimizing downtime and enhancing satisfaction. In terms of environmental sustainability, Canon has made significant strides through its Green Platform and Circular Economy initiatives, effectively recycling over 444,000 tonnes of toner cartridges and committing to achieve net-zero CO2 emissions by 2050. The emphasis on Product Lifecycle Decarbonization highlights Canon's proactive approach to reducing its environmental footprint across all stages of its products' lifecycles.

The implications of this research extend beyond Canon; they offer valuable insights for other manufacturing firms seeking to balance profitability with sustainability through digital transformation. By adopting similar technologies and practices, companies can enhance their competitiveness while contributing to broader environmental and social goals.

In conclusion, this study demonstrates that digitalization is not merely a technological shift but a comprehensive strategy that can redefine the operational and environmental landscape of manufacturing firms. The integration of advanced technologies, sustainable practices, and social responsibility will be crucial for firms aiming to thrive in the increasingly complex and competitive global market. Future research may explore the long-term effects of digitalization on sustainability outcomes across different industries, further enriching our understanding of this vital topic.

REFERENCES

Bertalanffy, L. (1969). General System Theory: Foundations, Development, *Applications.* New York: George Braziller.

Canon. (2022). *Canon Sustainability Report.*

Cao, G., Duan, Y., Edwards, J., & Dwivedi, Y. (2021). Understanding managers' attitudes and behavioral intentions towards using artificial intelligence for organizational decision-making. *Technovation, https://doi.org/10.1016/j.technovation.2021.102312*.

Chang, M., Ong, S., & Nee, A. (2017). Approaches and Challenges in Product Disassembly Planning for Sustainability. *Procedia Cirp*.

Chaniago, H. (2022). The effect innovation cloning to small business success: entrepreneurial perspective. *Journal of Innovation and Entrepreneurship*, *11*(1), 52.

Chaniago, H., & Efawati, Y. (2024). Individual Innovative Behavior Model: The Role of Entrepreneurial Leadership in Uncertain Times. *Quality-Access to Success*, *25*(202).

Cosar, M. (2019). Carbon footprint in data center: A case study. *Fresenius Environmental Bulletin*.

Efawati, Y., & Harmon, H. (2018). The Strategies of Small Business in Floriculture Industry. In *of the 2nd Global Conference on Business, Management and Entrepreneurship (GCBME 2017)-Increasing Management Relevance and Competitiveness* (pp. 118-124). https://doi.org/10.5220/0007115801180124

Efawati, Y., Ahman, E., & Chaniago, H. (2021, September). The effect of entrepreneurial leadership on firm innovation through innovative work behavior. In *5th Global Conference on Business, Management and Entrepreneurship (GCBME 2020)* (pp. 188-194). Atlantis Press. https://doi.org/10.2991/aebmr.k.210831.037

de Sousa Jabbour, A., Jabbour, C., Foropon, C., & Godinho Filho, M. (2018). When titans meet – Can industry 4.0 revolutionise the environmentally-sustainable manufacturing wave? The role of critical success factors. *Technological Forecasting and Social Change. (https://www.sciencedirect.com/science/article/pii/S0040162517314877)*.

J.Olah, Aburumman, N., Popp, J., Khan, M., Haddad, H., & N.Kitukutha. (2020). Impact of Industry 4.0 on environmental sustainability. *Sustainability*.

Kamble, S. S., Gunasekaran, A., Ghadge, A., & Raut, R. (2020). A performance measurement system for industry 4.0 enabled smart manufacturing system in SMMEs- A review and empirical investigation. *International Journal of Production Economics, vol 229, https://doi.org/10.1016/j.ijpe.2020.107853*.

Legner, C., Eymann, T., Hess, T., Matt, C., Böhmann, T., Drews, P., . . . Ahlemann, F. (2017). Digitalization: Opportunity and Challenge for the Business and Information Systems Engineering Community. *Business Information Systems Engineering, Vol.59*, 301-308.

Liao, Y., Deschamps, F., Loures, E. R., & Ramos, L. F. (2017). Past, present and future of Industry 4.0 - a systematic literature review and research agenda proposal. *International Journal of Production Research, Vol. 55 No. 12*.

Liu, K. P., Chiu, W., & Chu, J. (2022). The Impact of Digitalization on Supply Chain Integration and Performance: A Comparison Between Large Enterprises and SMEs. *Journal of Global Information Management, http://doi.org/10.4018/JGIM.311450*, 1-20 .

Liu, Y., Heinberg, M., Huang, X., & Eisingerich, A. B. (2023). Building a competitive advantage based on transparency: When and why does transparency matter for corporate social responsibility? *Business Horizons*, 517-527, https://doi.org/10.1016/j.bushor.2022.10.004.

Martínez-Peláez, R., Ochoa-Brust, A., Rivera, S., Félix, V. G., & Ostos, R. (2023). Role of Digital Transformation for Achieving Sustainability: Mediated Role of Stakeholders, Key Capabilities, and Technology. *Sustainability*, 15(14), 11221; https://doi.org/10.3390/su151411221.

Meadows, D. (2008). *Thinking in Systems: A Primer.* Chelsea Green Publishing.

Milusheva, V. (2020). Analysis Of Competitiveness Of Business Organizations. *Trakia Journal of Sciences*.

Nuraini, A., Chaniago, H., & Efawati, Y. (2024). Digital Behavior and Impact on Employee Performance: Evidence from Indonesia. *Journal of Technology Management & Innovation*, *19*(3), 15-27.

Okot, T., Madrigal-Mendez, P., & Solorzano-Arias, D. (2023). The Internet of Things (IoT) for Sustainability: A Framework for Costa Rica. *Journal of technology management & innovation*, vol.18 no.4, http://dx.doi.org/10.4067/S0718-27242023000400003.

Porter, M. E., & Heppelmann, J. E. (2017). Why Every Organization Needs an Augmented Reality Strategy. *Harvard Business Review*, 95, no. 6 (November–December 2017): 46–57.

Porter, M., & Kramer, M. (2019). Creating shared value: how to reinvent capitalism—and unleash a wave of innovation and growth. *Springer, Dordrecht. https://doi.org/10.1007/978-94-024-1144-7_16*.

R. Neugebauer, S. H. (2016). Industrie 4.0- Form the perspective of apllied research. *49th CIRP conference on Manufacturing systems* .

Rüßmann, M.; Lorenz, M.; Gerbert, P.; Waldner, M.; Justus, J.; Engel, P.; Harnisch, M. (2015). *Industry 4.0: The Future of Productivity and Growth in Manufacturing.* Boston Consulting Group.

Thariq, F., & Efawati, Y. (2024). The Influence of Website Quality on Buying Interest Consumer. *International Journal Administration, Business & Organization*, *5*(3), 64-74.

The Directorate-General for Climate Action, EU. (2024). *Consequences of climate change*. Retrieved from https://climate.ec.europa.eu/climate-change/consequences-climate-change_en

World Bank. (2013). *Inclusion Matters : The Foundation for Shared Prosperity.*

Zainon, S., Raja Ahmad, R. A., Ismail, R. F., Rahmat, N. H., & Sholihah, R. A. (2023). Corporate Social Responsibility Communication: A Brief Review. *International Journal of Academic Research in Business and Social Sciences*, 877-8877, DOI:10.6007/IJARBSS/v13-i6/17248.

Zhang W, Z. H. (2022). An Empirical Analysis of the Impact of Digital Economy on Manufacturing Green and Low-Carbon Transformation under the Dual-Carbon Background in China. *International Journal of Environmental Research and Public Health*.

Zhu, Y., Zhang, H., Siddik, A. B., Zheng, Y., & Sobhani, F. A. (2023). Understanding Corporate Green Competitive Advantage through Green Technology Adoption and Green Dynamic Capabilities: Does Green Product Innovation Matter? *Systems, https://doi.org/10.3390/systems1109046*, 1365-1370.