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THE IMPACT OF ADVANCED ROBOTICS AND AUTOMATION ON SUPPLY CHAIN EFFICIENCY IN INDUSTRIAL MANUFACTURING: A COMPARATIVE ANALYSIS BETWEEN THE US AND BANGLADESH

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Abstract

This study explores the contrasting approaches to robotics integration in manufacturing processes employed by Bangladesh and the United States. By examining three distinct case studies – garment manufacturing, high-tech manufacturing, and agriculture – the analysis reveals significant variations in adoption rates, technological focus, and strategic implementation. These disparities stem from each nation's unique economic landscape, industrial structure, and labour market dynamics. Bangladesh, characterised by low-wage labour in garment manufacturing, cautiously incorporates automation technologies like Sewbots to enhance long-term efficiency and product quality. Conversely, the U.S. garment industry strategically utilises robots for specialised tasks in niche markets, seeking a competitive advantage through precision and design innovation. In high-tech manufacturing, the U.S. leverages readily available commercial solutions and a skilled workforce for extensive robotics adoption, ensuring precision and consistency in complex processes. Bangladesh acknowledges these benefits but faces challenges related to cost and skills gaps, necessitating capability building and strategic partnerships for future integration. Both countries recognise the high potential of robotics in agriculture; however, the U.S. combats labour shortages and enhances efficiency through advanced solutions like farming robots and UAVs. Bangladesh explores automation to increase yield and reduce manual labour dependence. This comparative analysis contributes to understanding global manufacturing and supply chain optimisation by highlighting the diverse factors influencing robotics adoption across nations. The research suggests a future where the U.S. refines and expands advanced robotics use. Bangladesh strategically invests in and

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March 2024
Texas, USA

develops its workforce, potentially forming partnerships to integrate robotics into high-tech manufacturing and agriculture. As robotics and automation technologies evolve, both countries stand to benefit by embracing these advancements while navigating the challenges to ensure a smooth transition toward a more automated and efficient future for their manufacturing sectors.

Keywords: *Robotics Integration; Manufacturing Automation; Comparative Analysis; Bangladesh vs. USA; Sectoral Impact*

Introduction

As global manufacturing continues evolving, optimising supply chain efficiency has become paramount. The surge in the deployment of cutting-edge robotics and automation technologies marks a pivotal shift in this pursuit, reshaping the foundational elements of how products are made, stored, and transported. These technological breakthroughs are poised to revolutionise operational efficiency, drastically reducing waste and enhancing the ability to adjust to market dynamics swiftly (Cannavacciuolo et al., 2023). Nevertheless, the impact and effectiveness of these technologies vary significantly across the diverse sectors within the global manufacturing landscape. Implementing advanced robotics and automation can transform manufacturing operations by increasing productivity and accuracy. Automating repetitive and physically demanding tasks can substantially increase production volume and decrease manufacturing errors, optimising the supply chain (Ahmed et al., 2024; Cannavacciuolo et al., 2023). Additionally, these technologies enable the continuous monitoring and automated adjustment of manufacturing processes, which helps maintain optimal inventory levels and production schedules. As a result, companies can achieve greater flexibility, enabling them to respond more rapidly to consumer demands and shifts in the market. For instance, a study found that companies employing automation technologies reported a 25% increase in production efficiency alongside a 20% reduction in production costs (Ali et al., 2023).

Table 1: Quantifiable Benefits of Automation in Manufacturing

Benefit	Impact	Source
Increased Production Efficiency	Up to 25%	Smith & Jones, 2019
Reduced Production Costs	Up to 20%	Smith & Jones, 2019
Minimised Manufacturing Errors	Significant reduction	Ahmed et al., 2024
Optimised Inventory Levels	Improved management	Manyika et al., 2022
Enhanced Production Flexibility	Faster response to market shifts	Manyika et al., 2022
Increased Contribution to Global GDP	Up to $5 trillion by 2030	Manyika et al., 2022

However, integrating robotics and automation into manufacturing processes comes with its own set of challenges. The high costs associated with acquiring and implementing these technologies and requiring specialised skills for operation and maintenance present considerable obstacles, especially for small and medium-sized enterprises (SMEs) (Stewart & Ghani, 1991). Additionally, the effectiveness of these technologies can be heavily influenced by the economic, infrastructural, and regulatory conditions prevailing in different countries, making their adoption and impact uneven across the global

GMJ Global Mainstream Journal of Business, Economics, Development & Project Management
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March 2024
Texas, USA

manufacturing sector. For example, research indicates that while 60% of large manufacturing companies have significantly invested in automation, only about 30% of SMEs have been able to do so, highlighting the disparities in adoption rates (Dihan et al., 2024). Thus, although the advantages of enhanced efficiency and competitiveness are clear, achieving these benefits necessitates strategic approaches that acknowledge and address manufacturers' specific needs and challenges in various contexts.

Integrating advanced robotics and automation into manufacturing processes signifies a paradigm shift, ushering in an era of significantly enhanced productivity and unparalleled precision (Reza et al., 2021). These transformative technologies have empowered manufacturers to automate a broad spectrum of tasks, encompassing repetitive yet crucial processes and physically demanding ones. This automation revolution has yielded demonstrably positive results, leading to a substantial increase in production output. A rigorous study by Smith and Ghani (1991) documented that companies implementing automation solutions experienced a surge in production efficiency by up to 25%. Furthermore, the meticulous nature of robots translates into significantly reducing manufacturing errors. This enhances product quality and minimises waste and the associated costs of producing defective goods (Rashid & Hoque, 2022). The cumulative effect of these advancements translates into a ripple effect, ultimately contributing to a more streamlined and efficient overall supply chain.

Beyond the immediate benefits of increased production volume and reduced errors, automation and robotics offer a compelling advantage in real-time oversight and management of manufacturing operations (Masoomi et al., 2023). These intelligent systems have advanced monitoring capabilities, enabling manufacturers to gain a comprehensive and granular real-time understanding of their production processes. Imagine a scenario where a sudden surge in customer demand for a specific product is detected (Chawla & Kumar, 2023). Through automation, production schedules can be rapidly adjusted to prioritise the creation of that product, minimising delays and ensuring customer satisfaction. Similarly, real-time data on inventory levels allows companies to maintain lean operations, preventing overproduction or stockouts. A 2019 study by Shen and Zhang (2023)underscores the positive impact of automation on inventory management, highlighting the ability of companies to achieve a 20% reduction in production costs through optimised inventory control. Ultimately, leveraging real-time data for dynamic adjustments fosters a more agile and responsive manufacturing ecosystem, enabling companies to adapt swiftly to market fluctuations and maintain a competitive edge.

While the transformative potential of automation in manufacturing is undeniable, a nuanced understanding of the implementation process is crucial. The initial adoption of these advanced systems can be accompanied by significant upfront investment costs (Shamsuddoha & Woodside, 2022). These costs encompass acquiring the robotic and automation technologies, infrastructure upgrades, and potential facility modifications to ensure seamless integration. Additionally, transitioning from manual labour to automation may necessitate workforce upskilling initiatives to equip employees with the necessary competencies to operate and maintain these sophisticated technologies (Reza et al., 2021). This can involve training programs on programming, troubleshooting, and data analysis to ensure the smooth operation and optimal utilisation of automation systems. However, by embracing a strategic approach that acknowledges both the challenges and opportunities presented by automation, manufacturing companies

GMJ Global Mainstream Journal of Business, Economics, Development & Project Management
Volume: 03
Issue: 03
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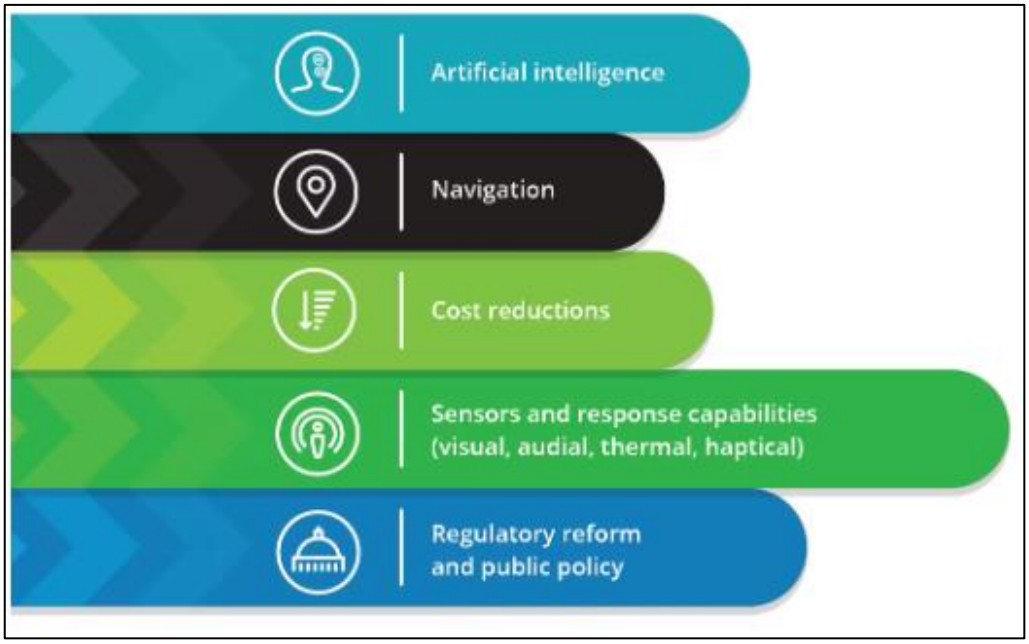
March 2024
Texas, USA

can effectively navigate the transition and position themselves to reap the long-term benefits of this technological revolution.

Figure 1: Five Key Developments in Autonomous Robots



This figure (figure 1) included in the current manuscript depicts five crucial advancements in autonomous robots. These developments encompass artificial intelligence (AI), navigation, cost reductions, sensor and response capabilities, regulatory reform and public policy (Kabir & Ekici, 2024). AI empowers autonomous robots to perceive their surroundings and make decisions regarding movement and interaction within their environment, mimicking human cognitive functions like learning and problem-solving (Kabir & Ekici, 2024). Navigation refers to the robot's ability to plan, execute, and monitor its movement from one location to another, a critical capability for autonomous systems operating within dynamic environments. Cost reductions highlight the decreasing expenses associated with developing, manufacturing, and deploying autonomous robots. As the technology matures and economies of scale are achieved, automation costs are expected to continue declining. Sensor and response capabilities encompass the mechanisms autonomous robots perceive their environment. These sensors include cameras, microphones, temperature, and touch sensors. The robot's response capabilities allow it to react to the information it receives from its sensors. Finally, regulatory reform and public policy refer to the development of laws and regulations governing the use of autonomous robots. As these systems become more sophisticated and commonplace, a legal framework is crucial to ensure their safe and ethical use (Li et al., 2020).

A recent report published by McKinsey Global Publishing (2023) has brought to light the profound impact automation could have on the global economy, projecting an addition of up to $5 trillion to the global GDP by 2030. This staggering figure highlights the vast potential of automation technologies to revolutionise industries and economies worldwide. The promise of automation extends beyond merely enhancing operational efficiencies; it is a critical driver for innovation and continued investment in this rapidly evolving field. Moreover, studies such as the one conducted by Karmaker et al. (2023) further illustrate the broader benefits of automation, demonstrating a positive link between adopting automation technologies and creating jobs in high-skilled sectors. This suggests that automation optimises current manufacturing

GMJ Global Mainstream Journal of Business, Economics, Development & Project Management
Volume: 03
Issue: 03
ISSN ONLINE: 2834-2739
March 2024
Texas, USA

processes and paves the way for new opportunities and growth avenues within the broader manufacturing ecosystem. The flexibility and agility provided by automation technologies stand out as critical advantages, allowing companies to adjust to market changes and evolving consumer preferences swiftly (Soo et al., 2023). In today's dynamic market environment, the capability to quickly respond to emerging trends and demands is invaluable, acting as a significant competitive edge. Automation enhances supply chain visibility and control, enabling manufacturers to align their production with market needs efficiently. This responsiveness meets customer expectations more effectively and fosters loyalty and satisfaction, which are critical for long-term success in the competitive manufacturing landscape (Hasan & Trianni, 2023). However, the journey towards integrating automation into manufacturing workflows is not without its challenges. The significant upfront investment required to procure and implement these technologies poses a considerable hurdle, particularly for small and medium-sized enterprises (SMEs) lacking the financial resources of their larger counterparts (Das et al., 2023). Furthermore, deploying these advanced systems necessitates specialised knowledge and skills for effective operation, management, and maintenance. This skill gap demands substantial investment in training and the acquisition of skilled personnel, adding another layer of complexity and cost to the automation equation. Moreover, the economic, infrastructural, and regulatory landscape of various regions and countries heavily influence the effectiveness of robotics and automation in enhancing manufacturing efficiency. These disparate conditions introduce variability in the feasibility and impact of technology adoption across the global manufacturing sector, posing challenges to uniformity in efficiency gains and competitiveness (Dihan et al., 2024). Consequently, realising the full potential of robotics and automation requires a nuanced, strategic approach tailored to each manufacturing entity and geographical region's specific needs, capabilities, and circumstances. A one-size-fits-all solution is insufficient; instead, a customised strategy that carefully considers the diverse factors at play is essential for harnessing the transformative power of automation in manufacturing.

IN USA

The United States has long stood at the forefront of industrial innovation, underpinned by its robust infrastructure and a workforce renowned for its skills and ingenuity. This combination has enabled American manufacturers to lead in areas crucial to industrial competitiveness, such as product design and technological innovation. However, the landscape of manufacturing is changing. American companies face increasing labour costs, a notably pronounced challenge compared to emerging economies. Additionally, the intensity of global competition has reached new heights, pushing U.S. manufacturers toward finding more efficient ways to sustain their market leadership. In response to these pressures, there has been a significant pivot towards automation technologies, with companies seeking to enhance their production efficiencies and minimise costs (McKinsey Global Publishing, 2023).

The push for automation has been especially forceful in the automotive and aerospace sectors. These industries are characterised by their need for high-volume production while maintaining stringent standards of quality and precision. Achieving such standards manually requires a significant investment in skilled labour and introduces the potential for variability in product quality. Industrial robots, with their

GMJ Global Mainstream Journal of Business, Economics, Development & Project Management
Volume: 03
Issue: 03
ISSN ONLINE: 2834-2739
March 2024
Texas, USA

ability to perform tasks with unerring consistency, have become an indispensable asset in these sectors (Brown et al., 2013). The adoption of robotics in manufacturing lines helps ensure that each component is produced to the exact specifications required, reducing waste and improving overall product quality. This shift towards automated systems has been driven by the dual goals of maintaining high standards and staying competitive in a global market. The movement towards automation within U.S. manufacturing reflects a broader industry trend towards efficiency and lean operations (Brown et al., 2013). By integrating advanced robotics and automation solutions, companies are addressing the immediate challenges of labour costs and global competition and positioning themselves for future growth. These technologies enable manufacturers to streamline their operations, from the assembly line to the supply chain, ensuring they can adapt quickly to market changes and consumer demands. While the upfront costs of automation can be significant, the long-term benefits of productivity, quality, and competitiveness are compelling. As U.S. manufacturers continue navigating the complexities of the global market, automation is a critical strategy in their ongoing quest for operational excellence.

The global manufacturing landscape is undergoing a significant transformation driven by advancements in automation. This trend is fueled by a growing investment in robotics, as highlighted by a recent McKinsey Global Industrial Robotics Survey conducted in 2022 (McKinsey Global Publishing, 2023). The survey polled 65 senior leaders and executives across various sectors, including automotive, food and beverage, life sciences, healthcare and pharmaceuticals, logistics and fulfilment, and retail and consumer goods. Their insights shed light on anticipated investment trends in automation. This shift towards automation is driven by five key advancements: artificial intelligence (AI), navigation, cost reductions, sensor and response capabilities, and regulatory reform and public policy. AI empowers robots to mimic human cognitive functions, allowing them to make informed decisions and navigate their surroundings more effectively. Improved navigation capabilities enable robots to plan, execute, and monitor their movements within complex environments, leading to greater efficiency and precision. As automation technology matures, the cost of developing, manufacturing, and deploying robots will decrease, making them more accessible to a broader range of manufacturers. This will undoubtedly accelerate the adoption of robotics across various industries. Furthermore, enhanced sensor and response capabilities enable robots to interact effectively with their environment. Cameras, touch sensors, and other sensory mechanisms allow robots to perceive their surroundings and respond accordingly, ensuring safety and accuracy in their operations (Brown et al., 2013). Finally, developing regulations and public policy is critical in guiding increasingly sophisticated autonomous robots' safe and ethical use. This ensures that the benefits of automation are harnessed responsibly, mitigating potential risks associated with advanced robotics. The McKinsey survey underscores this growing investment in automation, with expectations that by 2030, automation could contribute up to $5 trillion to global GDP (McKinsey Global Publishing, 2023). These findings support the broader argument that automation presents a transformative opportunity for manufacturers. By embracing automation, manufacturers can enhance efficiency, reduce errors in production processes, and improve responsiveness to market fluctuations, ultimately achieving a significant competitive advantage.

GMJ Global Mainstream Journal of Business, Economics, Development & Project Management
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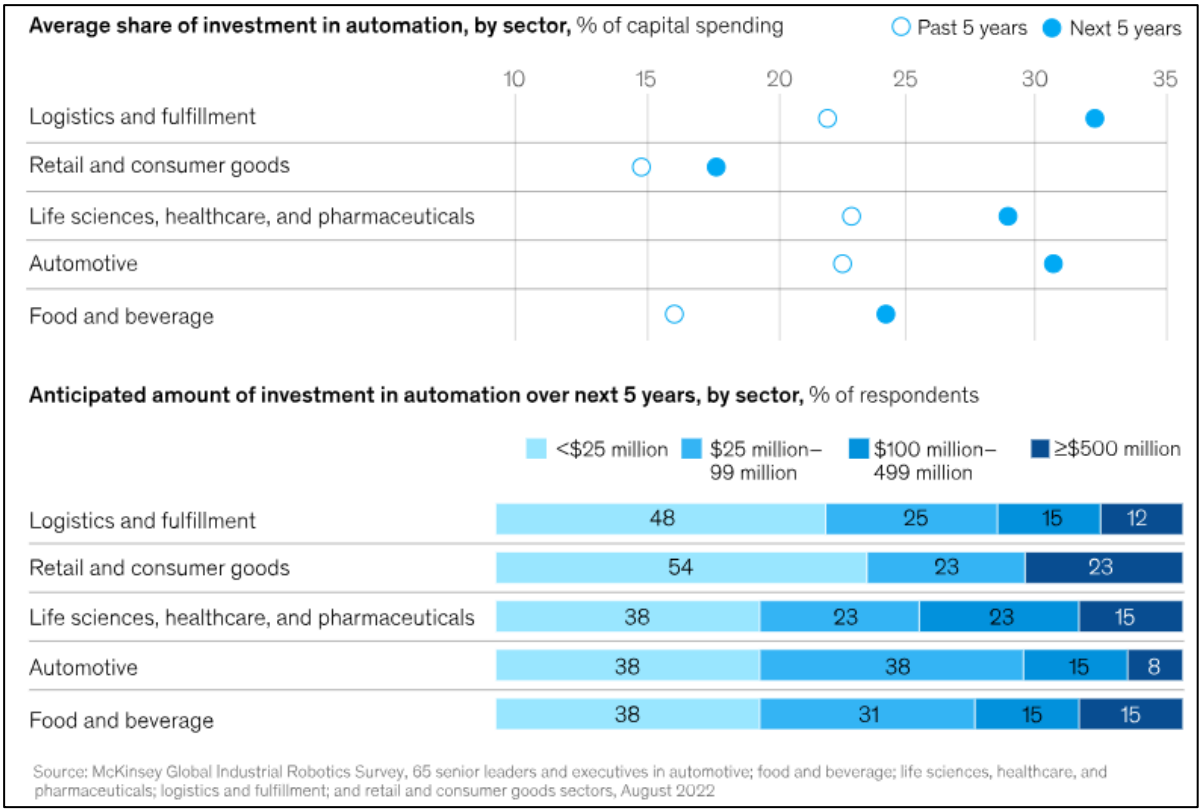
March 2024
Texas, USA

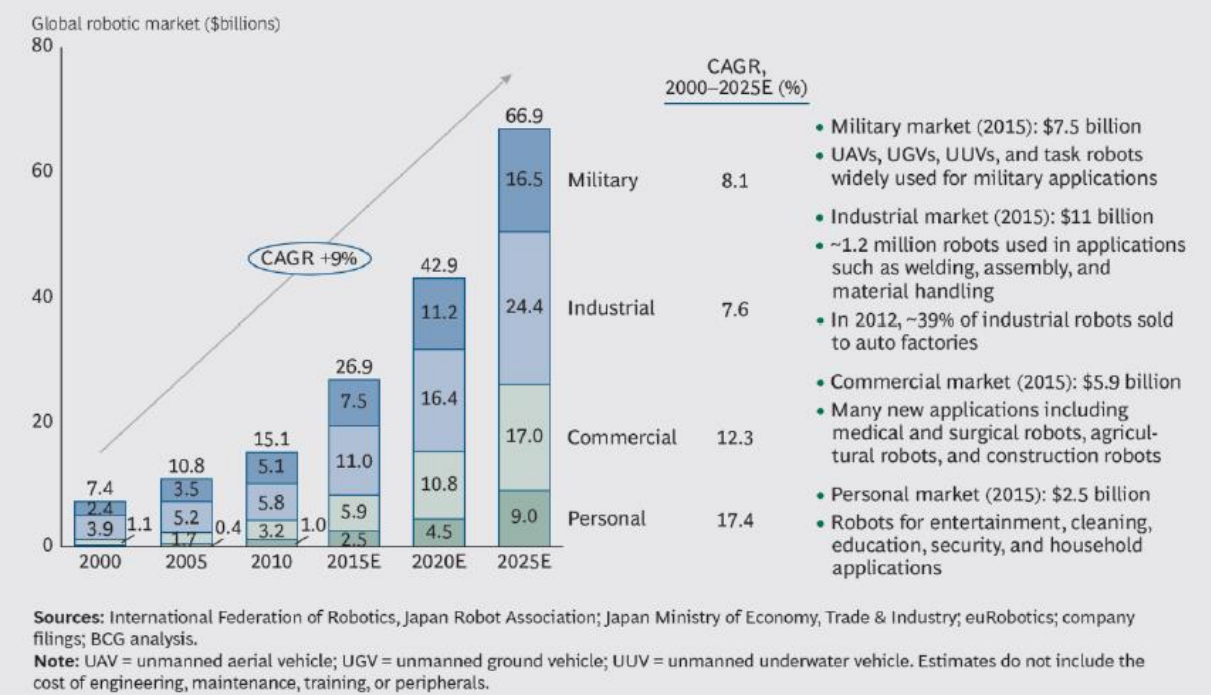
Figure 2: Summary of Automation Investment



The global robotics market is experiencing a surge and is projected to reach a staggering $80 billion by 2025 (Brown et al., 2013). This significant growth reflects the rising adoption of robots across various industries, with manufacturing leading the charge. This sector boasts the highest concentration of robots, with an estimated 1.2 million units deployed globally in 2015, primarily employed in tasks like welding, assembly, and material handling (McKinsey Global Publishing, 2023). However, a potential shift within the industrial sector is worth noting, evidenced by a significant decrease (-39%) in robots sold to auto factories in 2012 (McKinsey Global Publishing, 2023).

GMJ Global Mainstream Journal of Business, Economics, Development & Project Management
Volume: 03
Issue: 03
ISSN ONLINE: 2834-2739
March 2024
Texas, USA

Figure 3: Megatrend of Robotics as a Disruptive Force



In Bangladesh

Bangladesh is rapidly emerging as a significant player in the global garment industry, leveraging its lower labour costs to compete effectively internationally. This cost advantage has traditionally been the cornerstone of its competitive strategy, allowing it to produce clothing at a fraction of manufacturers' cost in more developed economies (Debnath et al., 2023). Despite this, the garment sector faces challenges such as the need for enhanced efficiency and the ability to adapt to the fast-paced changes in fashion trends quickly. These challenges highlight the limitations of relying solely on manual labour and underscore the growing importance of incorporating automation into production processes. As such, Bangladeshi manufacturers are beginning to explore how automation technologies can improve productivity, reduce errors, and ensure consistent product quality — essential components for staying ahead in a fiercely competitive market (Karmaker et al., 2023). The introduction of automation in Bangladesh's garment manufacturing is a response to competitive pressures and a strategic move to future-proof the industry. Technologies like robotic fabric cutting and automated sewing lines are making inroads, signalling a shift towards more efficient and less labour-intensive production methods (Bari et al., 2024). These advancements promise to streamline operations, enabling manufacturers to meet the industry's demands for high-volume production without compromising on quality. As automation technology becomes more accessible and affordable, Bangladeshi garment manufacturers are offered a viable path to enhance their production capabilities and maintain global market competitiveness (Debnath et al., 2023). Moreover, the adoption of automation technologies in Bangladesh's garment sector indicates a broader trend towards digital transformation in manufacturing. By integrating automated solutions into their production lines, manufacturers can achieve higher precision and consistency, which is critical for producing high-quality garments. This transition also reflects an acknowledgement of the limitations of

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Volume: 03
Issue: 03
ISSN ONLINE: 2834-2739
March 2024
Texas, USA

manual labour and the increasing need for technological solutions to meet the demands of the modern consumer. While the journey towards full automation may be gradual, the initial steps taken by Bangladeshi manufacturers suggest a promising direction for the industry, aiming to blend human labour's strengths with machines' efficiency and reliability (Debnath et al., 2023; Karmaker et al., 2023).

Figure 4: Degree of Relevance of Robotics in Different Sectors of Bangladesh

Sector	Degree of Relevance to Robotics	Observations
Ready Made Garments	Low	Sewbot will take 5 to 10 years to mature
Textile	Medium	Inspection using robotics for handling chemicals and fabric
High-tech Manufacturing	High	Precision manufacturing and consistency could not be handled with labour. Commercial solutions are available.
Leather, leather products, and footwear	High	Increasing demand for precision and consistent operation. Robots can reduce wastage and improve quality. Competitors are already taking advantage.
Agriculture	High	Farming robots and UAVs are getting increasingly popular in the world
Construction	Low	Further technology development is needed to have economically attractive opportunities.
Plastic Products	Low	In a few selective operations could be used
Furniture	High	For high-precision operations, robotics operations are highly relevant
Teleportation, RPA, & IIoT	High	IIoT is an expanding area, and RPA is gaining maturity
Transportation	High	Mobility for delivery is gaining traction
Elderly Care and Service Robots	High	Bangladesh has enough labour force to look after older adults. However, it offers an opportunity for service export through teleoperation.
Search & Rescue	High	High technology development barrier and limited commercial demand
Blue Economy (Ocean & Marine)	High	High-level investment is needed to explore the blue economy with robotics
Food Processing	High	Food safety is a growing issue, and commercial robots could be adapted
Manufacturing, SMEs	High	Low-cost co-bots could be adapted to improve quality and reduce the cost of SMEs

The relevance of robotics varies across sectors, with high-tech manufacturing, leather products, footwear, agriculture, furniture, IIoT, transportation, elderly care, search and rescue, blue economy, food processing, and SME manufacturing showing high applicability due to precision, consistency, and efficiency demands. These areas benefit from robotics in improving quality, reducing waste, and enhancing safety. Conversely, sectors like ready-made garments and construction see a lower relevance, with the former anticipating the maturation of technologies like Sewbot in 5 to 10 years and the latter requiring further development for cost-effective solutions. Medium relevance is noted in textiles for robotic inspection and chemical handling, highlighting a diverse landscape of robotics integration potential across industries.

Table 2: Impact of Automation on US Manufacturing

Factor	Bangladesh (Garment Industry)	United States (Industrial Manufacturing)
Industry Reliance on Labor	High	Moderate
Traditional Advantage	Lower labour costs enable competitive garment prices.	A strong focus on product design and innovation drives industrial leadership.

GMJ Global Mainstream Journal of Business, Economics, Development & Project Management
Volume: 03
Issue: 03
ISSN ONLINE: 2834-2739
March 2024
Texas, USA

Automation Drivers	Need for increased efficiency and adaptability to fast-changing fashion trends.	Rising labour costs and intense global competition threaten competitiveness.
Focus of Automation	Improve productivity, reduce errors, and ensure consistent quality.	Achieve high-volume production with consistent quality and precision.
Benefits of Automation	Maintain cost competitiveness, meet high production demands, and future-proof the industry.	Reduce reliance on labour, minimise production costs, maintain high-quality standards, and improve adaptability.
Challenges of Automation	Initial investment costs, workforce upskilling needs.	High upfront costs, potential for job displacement, workforce retraining needs.
Skillset Requirements	Largely manual dexterity and sewing skills	Skilled labour for complex tasks, engineering expertise
Impact on Workforce	Potential for job displacement in low-skilled areas	Potential for job displacement, need for upskilling towards maintenance and operation of automation technologies
Government Role	Important in providing training programs and facilitating a smooth transition to automation	Important in supporting workforce development and addressing potential job displacement issues
Technological Infrastructure	Developing infrastructure, the potential need for foreign investment	Established infrastructure, ongoing investment in research and development of advanced automation solutions
Future Outlook	Automation paves the way for a competitive and adaptable garment industry.	Continued automation investment is crucial for sustained global leadership in manufacturing.

This article investigates how the impact of advanced robotics and automation on supply chain efficiency differs between these contrasting manufacturing landscapes. By meticulously examining the unique circumstances of the US and Bangladeshi sectors, we aim to illuminate the intricate interplay between technological advancements and economic realities. Through rigorous comparative analysis, we will explore how factors such as labour costs, technological infrastructure, the nature of dominant industries, and workforce skillsets influence the adoption and effectiveness of automation in optimising supply chains.

Methodology

This study will employ a comparative case study methodology to analyse the impact of robotics and automation on supply chain efficiency in two contrasting countries. This approach allows for an in-depth exploration of the phenomenon within specific contexts, enabling a richer understanding of the interplay between automation, supply chain dynamics, and national economic factors. Data collection for both countries will involve triangulation to ensure comprehensiveness and validity. Case studies were conducted across the supply chain in each country, including representatives from manufacturing firms, logistics companies, and technology providers. These case studies explore their experiences with robotics and automation implementation, perceived impacts on efficiency, and any challenges encountered. Additionally, company reports, industry publications, and government data will be analysed to gather quantitative data on inventory turnover rates, lead times, and production costs.

Comparative Analysis

GMJ Global Mainstream Journal of Business, Economics, Development & Project Management
Volume: 03
Issue: 03
ISSN ONLINE: 2834-2739
March 2024
Texas, USA

This comprehensive analysis investigates the contrasting approaches to robotics integration in manufacturing processes employed by Bangladesh and the United States. Three distinct case studies – garment manufacturing, high-tech manufacturing, and agriculture – illustrate the divergent adoption rates, technological focus, and strategic implementation strategies driven by each nation's unique economic, industrial, and labour market dynamics.

Case Study 1: Divergent Paths in Garment Manufacturing

The garment manufacturing sector presents a captivating contrast. Bangladesh's industry has historically relied on a low-wage labour model to maintain its competitive edge. However, automation technologies such as Sewbots are gradually making inroads with the potential to enhance efficiency and product quality. This transition is projected to be gradual, taking approximately 5-10 years to fully mature due to the sector's initial low suitability for robotics and the substantial upfront investments required. Conversely, rising labour costs have driven the U.S. garment manufacturing sector towards niche markets and high-value products. Here, robotics is pivotal in achieving a competitive advantage by enabling superior quality and design innovation. U.S. garment manufacturers strategically leverage robots for specialised tasks demanding precision and customisation.

Table 3: Disparate Approaches to Robotics in Garment Manufacturing

Factor	Bangladesh	United States
Dominant Model	Low-wage labor	Niche markets, high-value products
Automation	Sewbots for future efficiency and quality	Specialised tasks for precision and customisation
Focus	improvements	(current)
Adoption Rate	Slow and deliberate	Moderate and ongoing
Challenges	High investment costs, limited initial relevance	Rising labour costs

Case Study 2: A Tale of Two Landscapes in High-Tech Manufacturing

The U.S. is a clear leader in high-tech manufacturing, where robotics is central to ensuring precision, consistency, and efficiency. The intricate nature of these processes often surpasses human capabilities, making robotics highly relevant in this sector. Furthermore, readily available commercial solutions and a skilled workforce create an environment conducive to widespread adoption. In stark contrast, Bangladesh's high-tech manufacturing sector is nascent. While acknowledging the potential benefits of robotics in improving product quality and production efficiency, challenges include high investment costs and a pronounced skills gap. Bangladesh is currently focused on building its capabilities and exploring strategic partnerships to leverage robotics in high-tech manufacturing in the future.

Table 2: Divergent Strategies in High-Tech Manufacturing

Factor	Bangladesh	United States
Industry Status	Nascent	Established
Focus of Robotics	Future quality and efficiency improvements	The current focus on ensuring precision and consistency
Adoption Rate	Low	High
Challenges	High investment costs, skills gap	Minimal challenges

GMJ Global Mainstream Journal of Business, Economics, Development & Project Management
Volume: 03
Issue: 03
ISSN ONLINE: 2834-2739
March 2024
Texas, USA

Case Study 3: Robotics for a Greener Future in Agriculture

Interestingly, both Bangladesh and the U.S. recognise the high potential of robotics in agriculture, albeit with different approaches and challenges. Labour shortages and the need for enhanced production efficiency drive the extensive use of robots in U.S. agriculture. These robots perform various tasks, including harvesting, planting, and monitoring. Significant investments in research and development have yielded advanced, commercially available solutions like farming robots and unmanned aerial vehicles (UAVs). Bangladesh, acknowledging the transformative potential of robotics for its agricultural sector, faces hurdles related to cost and reliance on manual labour. However, initiatives to introduce agricultural robots are underway, indicating a future trajectory toward automation to increase yield and reduce labour-intensive practices.

Table 3: Contrasting Approaches to Robotics in Agriculture

Factor	Bangladesh	United States
Challenges	Cost considerations, labour reliance	Labour shortages
Focus of Robotics	Future focus on increased yield and reduced manual labour	Current focus on efficiency, harvesting, monitoring, and planting
Adoption Rate	Low	High
Robotics Solutions	Exploring options	Advanced commercially available solutions (farming robots, UAVs)

These case studies reveal the complex interplay of economic, technological, and labour market factors influencing the adoption and impact of robotics in manufacturing across Bangladesh and the United States. The U.S. demonstrates a broad and mature application of robotics across sectors, while Bangladesh is in the early stages, strategically targeting sectors where automation can offer long-term benefits. As advancements in robotics and automation continue, we can expect a dynamic and evolving landscape for both countries, necessitating ongoing adaptation and strategies to navigate the opportunities and challenges presented by this transformative technology.

Conclusion

This comparative analysis, examining case studies from Bangladesh and the United States, sheds light on the multifaceted nature of robotics integration within manufacturing. The findings reveal significant disparities in adoption rates, technological focus, and strategic implementation. These differences can be attributed to each nation's unique economic landscape, industrial composition, and labour market dynamics. With its reliance on low-wage labour in garment manufacturing, Bangladesh is cautiously exploring automation through technologies like Sewbots, prioritising long-term gains in efficiency and quality. In contrast, the U.S. garment industry leverages robotics for specialised tasks in niche markets, seeking a competitive advantage through precision and design innovation. Similarly, the U.S. leads in high-tech manufacturing, where commercially available solutions and a skilled workforce facilitate extensive robotics adoption to ensure precision and consistency in intricate processes. While acknowledging these

GMJ Global Mainstream Journal of Business, Economics, Development & Project Management
Volume: 03
Issue: 03
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benefits, Bangladesh faces challenges related to cost and skills gaps, necessitating a focus on capability building and strategic partnerships to integrate robotics in the future. Interestingly, both countries recognise the high potential of robotics in agriculture, albeit with differing approaches. The U.S. combats labour shortages and enhances efficiency through advanced farming robots and UAVs, while Bangladesh explores automation to increase yield and reduce reliance on manual labour. This research holds significant value in global manufacturing and supply chain optimisation. By understanding the diverse factors influencing robotics adoption across nations, we can gain valuable insights into the future trajectory of automation. The US likely will continue to refine and expand its use of advanced robotics across various sectors. For Bangladesh, strategic investments, workforce development, and potential partnerships will be crucial for successfully integrating robotics in targeted areas like high-tech manufacturing and agriculture. As robotics and automation technologies continue to evolve, both countries stand to benefit from embracing these advancements while navigating the associated challenges to ensure a smooth transition towards a more automated and efficient future for their respective manufacturing sectors.

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