



A Transformative and Action Plan-Oriented Approach to Manufacturing Using Artificial Intelligence and Digital Technologies

Siddhartha Paul Tiwari

Google Asia Pacific, Maple Tree Business City, Singapore
Email: sidpaultiwari@gmail.com

ABSTRACT

The manufacturing industry has been affected in multiple ways by the pandemic. To maintain competitive advantages and foster innovation, the manufacturing industry must embrace digitization more than ever before. Digital transformation initiatives in the manufacturing sector will be successful if they are designed and implemented with the right technical knowledge, strategic frameworks, and best practices. A number of challenges arise when it comes to the implementation of digital technologies and the use of artificial intelligence in the manufacturing industry. A lot more than just technology, it is also very much about people and the processes they go through. The process of managing change can be complex and time-consuming, and this paper covers an action plan that can be used by manufacturing industries that are struggling with transforming their organizations with the use of artificial intelligence (AI) and digital technology as a tool for transformation.

Keywords: *Digital Technology, Artificial Intelligence, Manufacturing Optimization, Transformation Innovative Strategies, Pressure on manufacturing post pandemic.*

1. INTRODUCTION

Manufacturing encompasses a wide variety of industries, representing a large market for the industry. Innovative strategies for manufacturing are essential to achieving better results and lower costs [1]. It has been difficult to provide generic technology solutions to this industry due to the fragmented nature of the industry, which incorporates many technical and socio-economic perspectives. Industrial and digital (information) revolutions have undoubtedly had a significant impact on virtually all facets of our society, life, businesses, firms and employment [2]. Artificial intelligence is an area that is considered to be of fundamental importance for the future [3]. Industry 4.0 digital technologies, such as IoT, cloud computing, big data and analytics, have garnered much attention from both researchers and practitioners [4]. Having access to large amounts of digital data makes it possible for companies to generate new value [5]. There can be many benefits for the economy, the environment, and society from the use of digital technologies [6].

Fragmentation is caused in part by the way most manufacturers view their products, such as textiles, pharmaceuticals, steel, printing, automotive, electronics, petroleum, etc. The majority of organizations, however, operate in more than one of these broad categories at the same time. In the past, manufacturing has been hindered by an overly narrow lens approach, preventing it from taking full advantage of the advantages of artificial intelligence and technology, such as scale, operational efficiency, universality, and diversity.

2. HISTORIC CONTEXTS AND THE FUTURE OF MANUFACTURING

During the evolution and future of manufacturing, new trends in advanced manufacturing are emerging and serve as motivations [7]. Various manufacturing processes can be improved through the use of intelligent techniques and the use of process improvements to optimize various manufacturing functions [8]. The modeling and optimization of

advanced manufacturing processes is based on a wide spectrum of manufacturing processes. There has been a good demonstration of the latest technological advances in manufacturing [9].

Towards the beginning of the 1990s, the key technological impulse that had the greatest impact on

the transformation of services was the computerization and later what came to be known as the information and communication technology (ICT). There was a very different effect of the ICT revolution on the manufacturing sector than it had on other sectors.

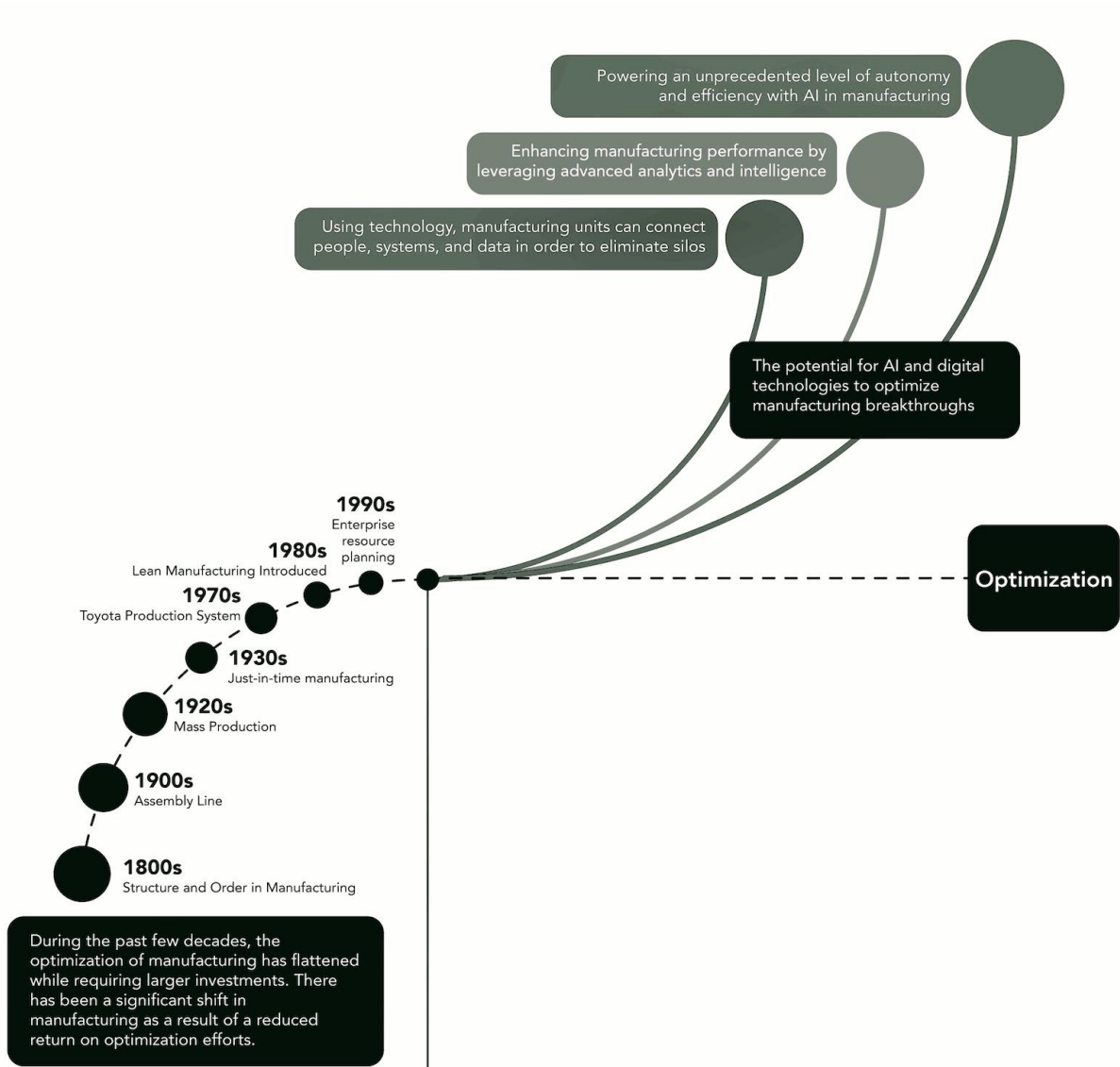


Figure 1: A historical and prospective view of manufacturing optimization

The development of the information and communication technologies two decades later has resulted in companies being able to take their high-tech knowledge abroad and combine it with low-cost labor in a way that combines technology with business outcomes in an effective way. The history of manufacturing is too often ignored in operations management, and its lessons are lost [10]. Furthermore, the manufacturing sector is evolving in ways that make

the traditional view that manufacturing and services are completely separate and fundamentally different sectors outdated. Manufacturers are increasingly relying on service inputs for a large portion of their production activities.

As of today, when it comes to the manufacturing industry as a whole, many of the processes are very rarely completely automated, while others require the

combined participation of human beings and technology in order to work effectively. There has been much talk about the potential of new opportunities for data-driven optimization of production processes as one of the key promises of Industry 4.0. This can be achieved by integrating all levels of information technology systems, ranging from machine control systems to manufacturing execution systems, and enterprise resource planning systems. Cobots (collaborative robots) are robots designed to interact directly with humans and handle shared payloads in collaboration with those workers [11]. The manual work of assembly still prevails in the majority of OEM and supplier plants today, especially in the production areas. Cobots (collaborative robots) are a type of robot that is capable of automating many assembly tasks by working closely with human workers.

It is important to note that not all automation is computer-driven; it includes hydraulic, pneumatic, mechanical, electrical, electronics, as well as computer-aided procedures, as well. In the manufacturing sector, automation refers to the use of technology to enhance efficiency, speed, and consistency in the manufacturing process in order to enable machines to carry out processes at higher levels of precision, speed, and consistency than humans can. There are often critical

components or complex materials that are incorporated into modern products that require specialized technological skills. It is extremely difficult for a single firm to produce everything on its own [12]. A growing number of manufacturers are looking for innovative ways of using computer software to design and integrate various components of the manufacturing system so as to achieve computer integrated manufacturing as a result. As manufacturing automation is at the forefront of emerging technological trends and innovation, companies are increasingly looking towards enhancing their operational and functional processes across the manufacturing value chain to improve their operational and functional efficiency.

3. POST-PANDEMIC MARKET CONDITIONS CONTINUE TO PUT PRESSURE ON MANUFACTURING

A pandemic disruption has predominantly affected the manufacturing industry in two ways; endogenous disruptions to manufacturing processes and systems, as well as extreme changes in demand and supply caused by exogenous supply chain disruptions [13].

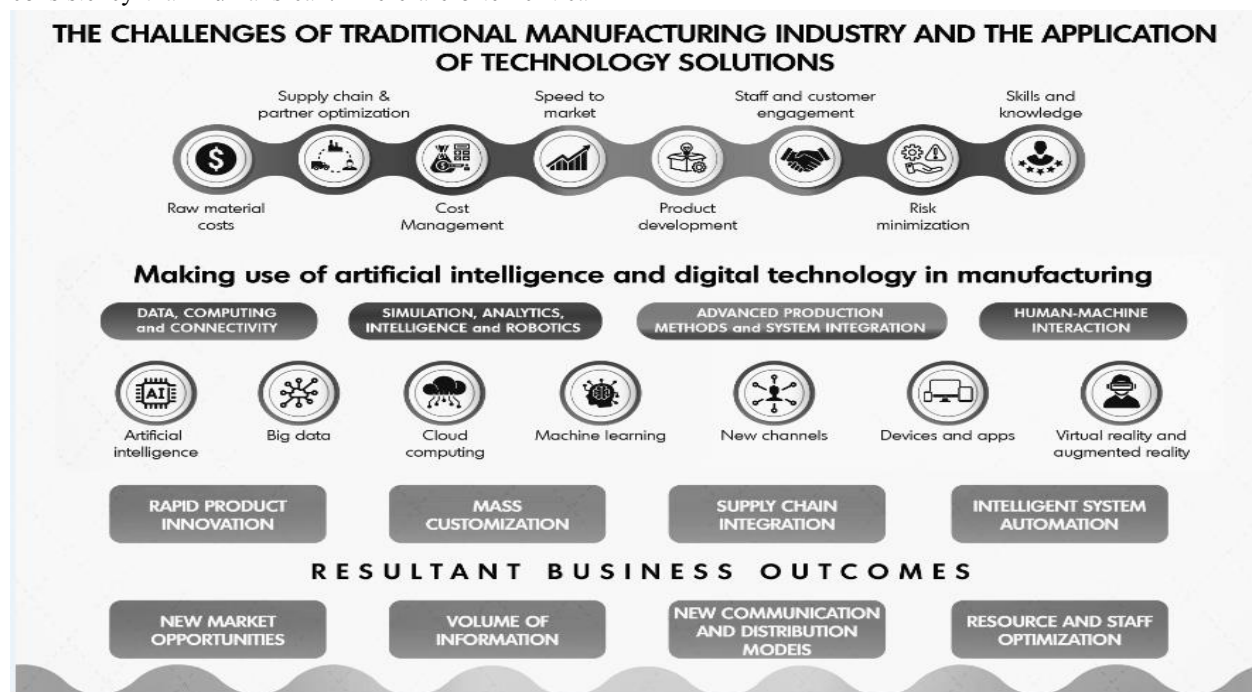


Figure 2: Challenges faced by manufacturing industry and outcomes based on implementing digital technology

A significant amount of time and money is being invested in digital transformations by the manufacturing sector post pandemic. In comparison to the leading factories of the past few decades, today's digitally enabled factories are very different from those of the past. In the last decade, digital manufacturing technologies have emerged as extremely promising technologies capable of reducing product development times and costs, as well as addressing the requirement for customization, improved product quality, and a faster response to market demands. [14]. The latest advancements in the fields of data and analytics, artificial intelligence, and machine learning, as well as the array of technology vendors in the global economies have made it possible for manufacturers to choose from hundreds of possible solutions and technology applications to improve their workflow.

The benefits of these solutions can be irresistible when they are implemented successfully. Digital technologies have already improved a wide range of processes within the manufacturing industry, resulting in significant reductions in machine downtime, improved throughput, higher labor productivity, and an improvement in production forecast accuracy.

As a result of the digital transformation, all aspects of manufacturing are set to undergo a profound transformation, both in terms of processes and productivity, as well as in terms of human resources. As a result of the proper use of digital technology, decision making can become much more powerful in the manufacturing industry. As the digital transformation progresses, it will open up a whole new range of opportunities for training that will allow for better utilization of human resources and will improve safety and satisfaction at the workplace as well.

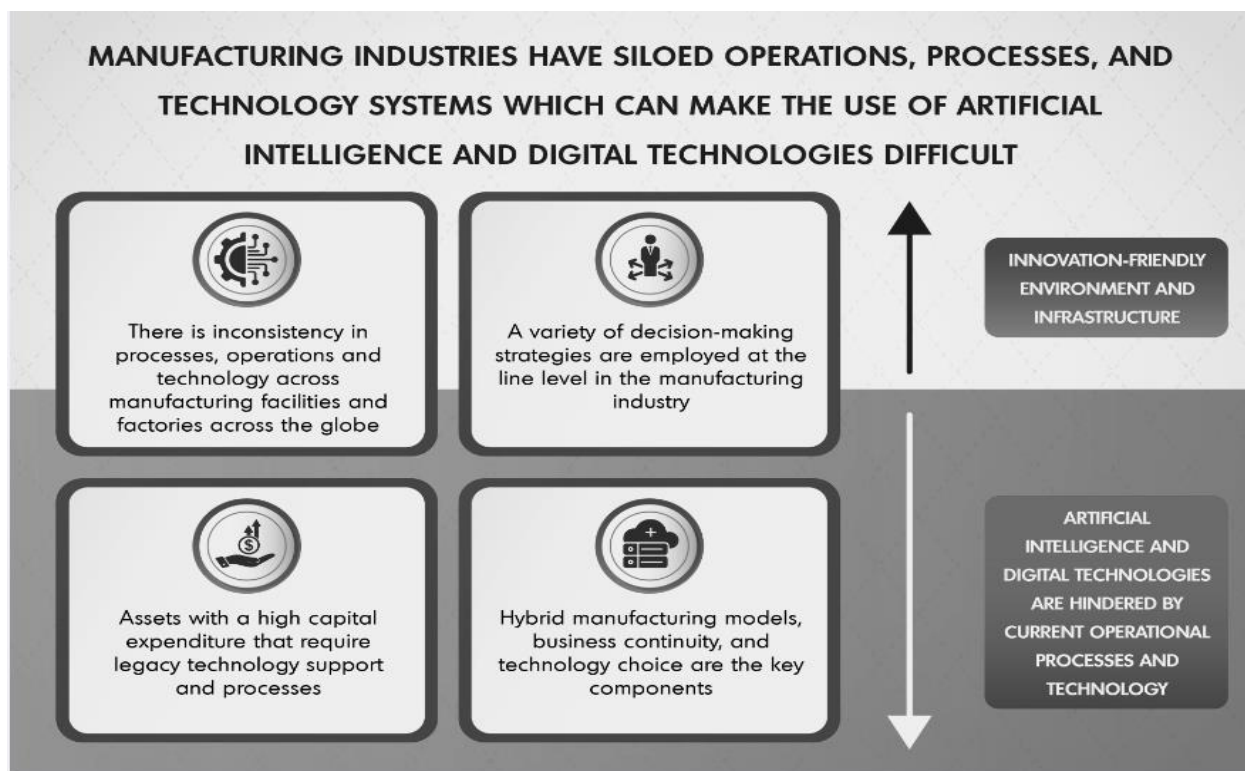


Figure 3: Manufacturing industry at the crossroads with digital technology

4. CHALLENGES RELATED TO DIGITAL TECHNOLOGIES AND ARTIFICIAL INTELLIGENCE

As a result of artificial intelligence (AI) and digital technologies, manufacturing companies are facing an

unprecedented challenge when it comes to fully transforming their organizations. An increasingly technologically advanced and connected world has created a whole new set of barriers that the manufacturing industry must overcome in order to survive. Managing production expectations and ensuring data privacy can prove to be a challenging task with the use of artificial intelligence and digital

technologies. Below, is a summary of top challenges faced by the manufacturing industry when it comes to digital technologies and artificial intelligence implementation.

4.1. Inadequate change management strategies

A change management process is a systematic approach to managing change within an organization. In this case, the management of digital transformation within the manufacturing industry constitutes a change management process. One of the primary reasons for the high failure rate in the manufacturing industry is a lack of proper organizational change management.

A further benefit of organizational change management is the fact that it focuses on multiple components of an organization rather than only one. Changing the culture, mindset, processes, structures, and the entire business model begins at the top. A solid and effective change management strategy is essential for a manufacturing organization's success, as it increases its chances of achieving its transformation goals.

4.2. Concerns regarding safety, privacy and trust

Many manufacturing industries are concerned about privacy and cyber security. The majority of digital transformation initiatives involve moving away from on-premise solutions to the cloud and consolidating all of a company's data into one system. With the adoption of remote work, digital processes, and cloud-based technologies, the manufacturing industry is exposed to higher levels of risk. Due to this, they are required to improve their cyber security and implement higher security measures in order to protect themselves from threats. There are numerous risks and negative consequences associated with failing to protect data and other valuable assets in the manufacturing industry. Consequently, manufacturers must take proactive steps to ensure their data and assets are secure. This includes implementing robust authentication processes, encryption, and regular security checks. Additionally, they should ensure their staff are properly trained to recognize and respond to potential threats.

4.3. Operational, process, and technology silos

Manufacturing departments and cross-functional teams often work in isolation, resulting in poor

collaboration and inefficient communication, inefficient resource allocation, excessive task effort, and fragmented approaches, which can undermine the success of digital transformation initiatives due to the ability to undermine collaboration and communication. An inefficient organizational structure and the lack of interaction between the operations and technology teams can thwart the flow of ideas and innovations, while a lack of consistency in data may negatively affect the decision-making process. Inefficient processes and an inability to adapt to new technologies may result from the lack of collaboration. Therefore, manufacturing industries may be left behind and unable to compete effectively.

4.4. Workforce issues and human resources

The manufacturing industry has historically relied heavily on manual labor to perform most of its tasks. Although the majority of jobs in the manufacturing industry will continue to require only manual labor in many industries for the foreseeable future, the skill level of people employed in this industry will need to keep pace with the changing nature of the job market even if many jobs will be reliant on only manual labor. A great deal of manual labor has already been replaced with automation and robotics in many areas, and this trend is likely to continue in the foreseeable future. Keeping up with the changes and ensuring that their workforce is up to date with the latest technologies and processes means that companies should invest in training programs so as to keep up with the changes. It is imperative that workers receive training in order to be able to understand and utilize these types of systems and to replace paper-based ones with these types of systems. The skill development of manufacturing industry personnel must be invested in in order to keep up with the demands of the job market in order to keep up with the pace of the industry. Training and other educational resources can help to achieve this goal. Moreover, it is important to provide employees with adequate support and resources so that they can keep up with the changes in the job market and be able to adapt to these changes as necessary.

4.5. Evaluation of the impact of digital transformation

Digital transformation has a significant impact on manufacturing industries, but the benefits are not always apparent or quantifiable. There may be a lack of confidence and reluctance to invest in future digital

initiatives as a consequence of this challenge, resulting in skepticism and a slowdown in progress. Companies must develop a clear roadmap for digital transformation and develop metrics for measuring success in order to address this challenge. As a result, confidence will be built and investment in digital initiatives will be encouraged.

A digital transformation project may not immediately yield results or be able to be quantified as opposed to traditional investments. Digital initiatives can improve the agility, the customer experience, the productivity of employees, and the engagement of employees within the manufacturing industry. Digital initiatives often provide benefits that go beyond financial metrics. By implementing digital transformation initiatives, organizations can become more efficient, agile, and customer-centric. Consequently, customers will be more satisfied, employee morale will be higher, and operations will be more efficient. Digital transformation efforts may be slowed down if it is difficult to accurately determine impact, leading to skepticism and reluctance to invest in future digital initiatives.

5. ACTION PLAN-ORIENTED APPROACH AND SOLUTION

Digital transformation is expected to become the top strategic business priority for the manufacturing industry over the next few years. There is a possibility that many manufacturing industries will accelerate their digital technology initiatives in the coming year.

Through the implementation of new digital processes and tools, the manufacturing industry has the opportunity to reimaging the way its operations are conducted. There are, however, several challenges facing the manufacturing industry at each stage of the digital transformation process.

Technology concerns and technical barriers are not always directly connected to digital transformation challenges. Other factors that are not related to technology include people-centric issues, organizational structures, and other non-technical factors. An action plan and solutions have been listed below by the authors:

5.1. Solutions centered on people and learning and development

In the manufacturing industry, there is a lack of experience in successfully implementing artificial intelligence and digital transformation, which results in many common roadblocks being overlooked, which delays implementation, leads to issues that could have been avoided, leads to frustration, and slows the adoption of initiatives. A shortage of human resources exists within the manufacturing industry. This is preventing the industry from both servicing its existing processes and learning and implementing updated processes when it comes to implementing the latest technologies. Lack of expertise and resources can result in significant delays in the implementation of initiatives related to artificial intelligence (AI) and digital transformation, resulting in decreased productivity and decreased return on investment (ROI). Customer dissatisfaction and lost business may also result from poorly executed initiatives.

5.2. System obsolescence and legacy systems

There are a number of reasons why legacy systems in the manufacturing industry are difficult to replace. For starters, they would have been tailored to the specific needs and environment of that particular manufacturing organization. A system of this nature would be expensive to replace, and the process could take many years to complete. Furthermore, data and knowledge accumulated over time may be lost. It follows that the system has also been designed to incorporate the collective wisdom of the employees throughout the years. It is possible to use this collective knowledge to increase the efficiency and quality of the organization's operations, enabling it to run more efficiently and cost-effectively. Consequently, this system can be an advantage for the organization. Although the system may be inefficient, employees and customers are familiar with its requirements and response times. Making them relearn would be a huge effort. A certain amount of change is inevitable at some point. Customers' needs may change, and statutory requirements may require some reporting systems to be added, making the situation worse. A change is inevitable when a competitor offers a product or service with an end-to-end revamped business model, and then an urgent need for change arises.

The solution to this problem can be found by integrating everything into a streamlined process and

integrating new technologies and efficiency measures, which will result in a streamlined process. This process will increase productivity, reduce costs, and improve customer satisfaction. In addition, this will lead to improved decision-making, better communication, and a reduction in errors.

5.3. The imperative of infrastructure modernization

Even though there is a need for a modernized infrastructure in order to implement AI and digital technologies effectively, many organizations rely on manual operations and take a reactive approach to implementing AI and digital technologies. Moreover, it is necessary to build sufficient excess capacity in order to ensure the reliability of the system. The key to driving the technological transformation of an organization is to have a comprehensive strategy along with a flexible architecture that can adapt quickly to changing business needs. Automation technologies should also be utilized by the manufacturing industry to streamline operations and reduce costs. This can be done by leveraging machine learning, real-time analytics, and cloud computing. Automation processes should be designed to be easily modified and upgraded, allowing for greater agility and scalability. In addition, security should be a top priority, to ensure that data is protected from malicious actors. Typical manufacturing industries have policies regarding a wide range of issues, including security, information access, and data management. Many of these requirements are manually enforced, which increases compliance costs and reduces effectiveness.

As a result, the manufacturing industry may have difficulty maintaining consistency across existing environments and extending established policies to new settings. Automating policy enforcement can help to reduce costs and improve efficiency. Additionally, integrating machine learning capabilities into the policy enforcement process can improve accuracy and reliability. The risk of business failure is increased when business rules and regulations evolve slowly. As an added consequence, many of these policies have been developed to support older paradigms of working, which reinforce legacy ways of working and create a barrier to agility and speed. As organizations shift to agile ways of working, traditional policy enforcement methods become less effective. Automation and machine learning offer a way to quickly adapt to changing regulations and business processes. This can

help to ensure policy compliance and reduce the risk of business failure. Manufacturers who are at the forefront of technological innovation have policies that incorporate technology both for automatic distribution of changes and for monitoring and enforcing them. Hybrid environments benefit from standard policies that lead to better compliance and a reduction in costs.

5.4. Redesign optimization of processes

Manufacturing industries are able to deliver great customer and employee experiences if they can operate seamlessly on the backend. An organization can streamline its workflows, digitize its processes, and automate a number of processes in order to create efficiency. Automating processes can reduce overhead costs and improve scalability. Furthermore, it facilitates the delivery of services and products more quickly, and it also increases customer and employee satisfaction. The manufacturing industry should redesign its business and products based on customer outcomes. It may be possible to boost operational efficiency and meet customer expectations by utilizing cloud software to accelerate change and by incorporating artificial intelligence.

5.5. Coordination and planning

The previous model of manufacturers working in silos hindered digital transformation, but this has now changed. The initiative has become a cross-functional initiative, requiring everyone to participate, including managers and employees.

When leaders implement a new piece of technology without engaging the users of the technology, they run the risk of investing in digital technologies that do not meet the company's needs. Having insight into the end-user experience is crucial to ensuring that a solution works correctly and does not introduce new challenges. When developing a new system, decision makers should ask employees about their experience with the existing system and how it can be improved. A new solution should be implemented, and stakeholders should continue to seek feedback from those who are actively using the technology. A cycle of continuous improvement should be initiated as a result of the insights gained from this feedback loop in the long run.

6. CONCLUSION

Almost every industry, including manufacturing, is being changed by technology in terms of the way business is conducted. Technology advancements have enabled manufacturers to streamline production processes, innovate at a faster pace, reduce costs and deliver a higher quality product to meet the demands of their customers as a result of the advancements in technology. Technology has the potential to revolutionize many aspects of manufacturing, as it is versatile and easy to use, so there are a number of areas within the manufacturing industry where it is being tapped.

New approaches to manufacturing are needed in order to take advantage of new technologies, such as artificial intelligence and digital technology. In the world of technology, there is a constant evolution of new technologies, and there is more going on than just robots replacing traditional workers. Manufacturing industries using new technologies such as using artificial intelligence and digital technologies collect valuable information from machines to benefit their production phases, assist with their overall performance, predict machine failure, reduce cost, increase product quality, improve customer service, and assist with research. It is clear that artificial intelligence and digital technologies will continue to evolve as we move forward into the future. To ensure a smooth transition into the future, global manufacturing companies should improve their technology capabilities as early as today. Manufacturing companies need to invest in advanced technologies such as robotics and automation, machine learning, and data analytics. These technologies will be necessary to facilitate a successful transition into the digital future. Manufacturers must also ensure that their employees are trained in the latest technologies to guarantee their success.

AUTHOR'S CONTRIBUTION

1. Siddhartha Paul Tiwari

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