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Digital Transformation - A Journey of Manufacturing sector into the future

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Abstract: Old business models are being modified, altered, and even abandoned as a result of the rapid expansion of the digital economy, which is shifting consumer expectations. A significant change is occurring in business due to the automation of manual procedures using cutting-edge technology. Digital manufacturing transformation refers to the use of new technologies to replace antiquated or non-digital manufacturing and near-manufacturing processes and operations in order to increase corporate performance. Through this technology-driven manufacturing strategy, companies can make efficient use of industrial solutions, react in real-time to shifting conditions and requirements, streamline processes, enhance management and internal workflow, optimize production, and transform any other aspect of their manufacturing processes **(Jayandaran Arumugam A, 2022)**.

Index Terms **– Digital transformation, Digitalization in Manufacturing Sector, Digital Journey of Manufacturing sector**

I. INTRODUCTION

The industry 4.0 revolution, which automates processes and enables real-time operation control, is what's driving the digital transformation of manufacturing. This can be accomplished successfully and efficiently by merging assets and data with digital and conventional production as well as utilizing effective technology. Digital manufacturing technologies connect systems and procedures from every stage of production to produce an integrated manufacturing process that spans product design, production, and servicing. It is possible to increase the effectiveness of manufacturing decision-making while also enhancing the processes to generate cost savings, shorten the time to market, and establish a joined-up manufacturing process that integrates digital tools with the actual physical execution of manufacturing through modeling and simulating processes (TWI, N.D.). Manufacturers can weave a digital thread across the production process to analyze data across the product lifecycle and develop techniques that can be put into practice by adopting a computer-centered manufacturing process. Client information can also be given to product managers via digital manufacturing systems so they can anticipate demand and any continuing maintenance needs to deliver products through production that is focused on the demands of the customer.

The product life cycle, the smart factory, and value chain management are the three components that make up digital manufacturing. Each of these refers to a different facet of the execution of manufacturing, from product design and innovation to the improvement of production lines and the optimum use of resources for better goods and customer satisfaction.
Engineering design is the first step in the product life cycle, which also includes sourcing, manufacture, and service life. Each phase makes use of digital data to enable design adjustments during the manufacturing process. Smart machines, sensors, and tooling are used in the "smart factory" to provide real-time feedback on processes and production technology. This digital transformation makes it possible for better visibility, control, and performance improvement of production processes by combining operations technology with information technology. In order to develop an optimal process with fewer inventories and preserve product quality and customer happiness, value chain management focuses on lowering resources.

The integration of information and communication technology (ICT) into every aspect of manufacturing is currently reshaping contemporary manufacturing, regardless of whether it is referred to as "Industry 4.0" in Europe, the "Industrial Internet of Things (IIoT)" in the United States, or simply "smart manufacturing." The landscape of international manufacturing rivalry is expected to change as a result of this fusion of digital technology and manufacturing industries (EZELL, 2018).

II. RESHAPING TO SMART MANUFACTURING

The emergence and development of a wide range of technologies, such as cloud computing, the Internet of Things, advanced sensor technologies, 3D printing, industrial robotics, data analytics, machine learning, and wireless connectivity that improves machine-to-machine (M2M) communications, are driving the development of smart manufacturing. One of these that is crucial is the Internet of Things, which was created by combining sensors and software (IoT). The Internet of Things (IoT) effectively gives things a "embedded computer" upgrade that enables interactivity and communication. The Internet of Things (IoT) will assist the deployment of transportation management systems, warehouse management systems, shop floor management systems, and manufacturing execution systems in both warehouses and shop floors. Manufacturing businesses can gain real-time insight into their production processes and the knowledge they need to make better operational and production decisions by integrating this

information from various machines on the factory floor with information from other factories throughout the production chain, including those of suppliers. By 2025, it is anticipated that the implementation of IoT would produce $1.2 to $3.7 trillion in value throughout the globe in four main ways: operational efficiency, predictive and preventative maintenance, supply chain management, and inventories and logistics (EZELL, 2018).

III. TO REACH NEXT DIGITAL FRONTIER, MANUFACTURERS MUST TAKE TWO CRITICAL MEASURES.

For the majority of manufacturers, all innovations serve as stepping stones towards the upcoming digital frontier. They represent enormous obstacles for how robust and responsible firms can be, as well as how relevant they can continue to be to customers and employees. To overcome these obstacles, they should concentrate their efforts on the following two areas:

Connecting technologies in an intelligent way : Companies need to connect Industry 4.0 technologies in a way that enables them to see much clearer and further ahead, allowing them to act and respond much quicker in accordance with what they see, in order to encourage significant change. For instance, cloud platforms for data sharing and processing; machine learning algorithms for data analysis and scenario building; and digital twins for scenario testing. The technologies create a digital thread when connected in an intelligent way to work together, allowing information to flow across people, things, processes, and facilities, from a company's research and product development through factory floors, supply chains, consumers, and back again.

This thread increases the transparency and visibility of the product development process, manufacturing workflow, market demands, and consumer behavior. It can be visualized as a positive feedback loop of digital copies of every step of the product development, engineering, and production process that enables businesses to foresee, keep track of, and respond to the effects of practically every activity.

Manage changes Wisely: The people agenda is equally, if not more, vital than the technology agenda. Just as the steam engine and conveyor belt introduced new working methods, so does digital technology. Traditional responsibilities will shift from carrying out manual activities to overseeing, interpreting, and directing intelligent devices and data as more and newer technology are introduced to the workplace. As a result, jobs will demand greater invention, creativity, teamwork, and leadership. Businesses that fail to acknowledge this and take action will be let down. For instance, according to a 2020 survey, 63% of businesses acknowledged that they had not been able to get the full benefit of their cloud expenditures. The individuals and changing dimensions turned out to be the main obstacles in their cloud adventure. In a similar vein, only 38% of supply chain leaders said that their employees were largely or fully prepared to use the digital tools that had been made available to them (Sef Tuma, 2022).

Manufacturing, both as an industry and as an organization, is trailing behind in terms of digitization. However, an increasing number of businesses now recognize that manufacturing is their next digital frontier and are concentrating their efforts on this vital area of the business. The necessity for and advantages of digital manufacturing are clear, and the technologies are accessible and have demonstrated their value. Companies that link technology properly and handle the change it brings can achieve far more than what Industry 4.0 offers in terms of efficiency and effectiveness.

IV. MAJOR COMPONENTS THAT PLAY KEY ROLE IN DIGITALIZATION

Manufacturers have a growing number of new tools and solutions at their disposal as the digital revolution progresses, giving them a variety of competitive advantages. Automation, extended reality, and artificial intelligence are three of the most significant instruments on the horizon that are assisting in addressing today's difficulties.

Artificial intelligence in Industry 4.0 : Approximately the next five years, the use of artificial intelligence (AI) is expected to increase at an annual pace of 57.2% across all industrial industries, resulting in a market worth over €14.02 billion by 2026. Therefore, it's crucial that manufacturers make investments in IT hardware that can handle specialized industrial applications like AI straight out of the box, assisting them in smoothly integrating the technology into their operations in the future (Paul Waddilove, 2022).

Extended Reality is being used more and more : The phrase "Extended Reality," often known as "XR" or "Cross Reality," refers to several technologies that produce artificial worlds and objects. The interaction they foster between the physical and digital worlds is what sets these various technologies apart and defines them. Virtual Reality (VR) immerses the user in a world that is entirely made of virtual items, as opposed to Augmented Reality (AR), which adds virtual objects to the actual world. The global market for Extended Reality is rising, and by 2023, it is predicted to reach 29.39 billion euros, a 170% growth in just two years (Paul Waddilove, 2022). The US and Europe will account for 60% of this industry. Low latency times are necessary for the utilization of these cutting-edge technology. For this reason, it's essential for manufacturers of laptops and tablets to include cutting-edge features like LiFi in their products. In contrast to Wi-Fi, which utilizes the radio frequency band of the electromagnetic spectrum, LiFi (or Light Fidelity) is a wireless communication method based on the use of visible light. Light doesn't interfere with radio frequencies, hence LiFi is compatible with radio technologies. This technology has many other benefits as well (Wi-Fi, 3G, 4G, etc.). Additionally, since light cannot penetrate through walls like radio waves can, barriers ensure the partitioning and security of data on both sides.

Manufacturing industry automation: Many areas of the manufacturing industry have already adopted automation and the usage of robots. For instance, it is estimated that 59% of firms in Germany currently make use of these technologies. As a result, over the next five years, the worldwide robotics industry is anticipated to increase by 20% annually, with automation estimated to grow by about 9% annually between 2018 and 2025. By 2026, it is anticipated that the overall volume will be close to 62.13 billion euros (Paul Waddilove, 2022). Manufacturing execution systems, enterprise resource planning, and other appropriate tools can help manufacturers build an IT infrastructure that will enable them to take advantage of these innovative new technologies as soon as possible. By doing this, they will be able to lead the industry and protect their investment for a long time to come.

V. SETTING UP STANDARD

Producers and consumers alike gain from the establishment of voluntary, industry-led, consensus-based, worldwide standards for goods and technologies. Internationally compatible standards lower the cost associated with making specific variations of items to satisfy the standards of many countries, allowing firms to take use of innovations and produce goods effectively at scale.

Regrettably, some countries are utilizing mandated standards as a mercantilist tool to restrict or bar foreign corporations from accessing their markets and to assist native industries, particularly ICT industries. Foreign governments may manipulate the global trading system on behalf of their own businesses by putting unfair standards-related restrictions on imports. This would increase costs for consumers as well as hurt a nation's ability to compete internationally in the digital economy. According to the OECD, according

to national technical standards can increase an imported good's price by as much as 10%. The use of globally applicable ICT standards, including those used in digital manufacturing, should therefore be encouraged by governments. Countries should avoid isolating, proprietary standards and siloed solutions.

To ensure that factories, machinery, and products created by global vendors can interact with one another and that solutions may be applied in any nation, a number of common protocols will be essential if the smart manufacturing goal is to be realized. Individual modules, components, devices, production lines, robots, machines, sensors, catalogues, directories, systems, databases, and applications will need common standards for the connections between them and the overall semantics, or how data is seamlessly passed from one device to another, according to the excellent report "Smart factory" in a Global Context: Strategies for Cooperating with International Partners.

If the international community is unable to standardize smart manufacturing, there are a variety of concerns. First off, the concept of "smart manufacturing" would be rendered useless if the sensors, equipment, and software made by several international vendors were unable to effortlessly communicate data, information, and intelligence in real-time. Furthermore, if there are no global standards or all-encompassing solutions to allow system interoperability, individual businesses run the risk of experiencing technology lock-in. Small and medium-sized enterprises (SMEs) are particularly impacted by this because they may be reluctant to invest in Digitalization technologies or systems because they worry that if they buy proprietary standalone or siloed solutions, they may end up becoming reliant on the technology of a single supplier (EZELL, 2018).

VI. CONCLUSION

The successful modernization of the industrial sector can be facilitated by effective management and administrative mechanisms that increase efficiency and management quality while establishing a digital approach to the environment and concern for the security and safety of sensitive data. implications of obtaining digital competencies and abilities for a nation's sustainable economic and social development (Molchanova, 2020). The volume and variety of interesting solutions accessible to manufacturers is constantly expanding as digitalization spreads throughout the production sector. For businesses that choose to adopt them, emerging technologies like AI, Extended Reality, LiFi, automation, and robotics can all greatly increase productivity and profitability.

Nations are vying intensely for leadership in sophisticated manufacturing. If nations want to keep up, they will need to implement a thorough national manufacturing digitization strategy and make the necessary investments. Small manufacturers, in particular, can't be expected to survive in this market on their own and will need to take advantage of government initiatives that support and promote their adoption of digital and other modern manufacturing processes and technology.

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