IoT-ENABLED MANUFACTURING SYNCHRONIZATION FOR E-COMMERCE

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Abstract
Businesses and manufacturing have benefited from the evolution of digital information technology. The introduction of e-commerce has changed the way companies are conducted, and the manufacturing industry is using emerging technologies to automate and synchronize production processes in order to increase productivity and profitability. The results of the study show that incorporating the internet into e-commerce has transformed the process, making it one of the most advanced and high users of digital technology. E-commerce has advanced by leaps and bounds, allowing products and services to flow electronically with minimal delays. Manufacturing has benefited from the implementation of IoT, which has increased the productivity of production processes and is gradually becoming a major beneficiary of modern computer technology.

Key words: *E-commerce; IOT; Emerging Technologies*

1. Introduction

The evolution of digital information technology has led to innovations in businesses and manufacturing. The advent of e-commerce has revolutionized the way businesses are conducted while the manufacturing sector is applying the new technology to automate and synchronize production processes for efficiency and profitability.

The past few decades have seen the imprints of information technology in various sectors of the economy. The use of wireless technology has led to a wide range of innovations that have seen a paradigm shift from the traditional way of doing things to new models in business and manufacturing. A unique manufacturing process controlled by the Internet of Things, IoT, has been introduced and is slowly taking over the manufacturing industry. IoT is an interconnection of devices that are controlled by specific software to perform a certain process. The internet plays a critical part in channelling data and information between them to execute the instructions. This interconnection has brought a new manufacturing platform where the human input is minimal, and every process is connected to the next one through wireless connections. There is a huge potential in this innovative manufacturing technology that is expected to take over shortly completely. **Mahmood (2020, p 20**) predicts that by 2030, systems using IoT will have over 90 billion devices connected.

IoT- internet of things is a system of inter-related computer-enabled devices that have been networked together to exchange data for performing essential services efficiently with minimum human input. The machines are interlinked through the internet to transfer data and enable a continuous flow of information between these devices to complete various complex operations. The IoT applies smart technology to transmit data, control tasks, and automate processes through the internet using a dedicated database (Dachyar, Zagloel, & Saragih, 2019, p. 654). This report highlights the background information on E-commerce and traces IoT in manufacturing and how this process is being synchronized into the e-commerce platform.

Why the research on IoT

This research intended to look at the application of information, digital, and internet computer technology in e-commerce and manufacturing. The most prominent application of the internet in the modern world is E-commerce. Internet of Things connects digital devices into a single platform where producers, distributors, and consumers exchange goods and services electronically and in real-time. IoT has enabled e-commerce to streamline all operations leading to phenomenal growth. This research intends to determine how manufacturing could be synchronized into the e-commerce IoT by integrating the entire production into the IoT platform. The research will look into the impact of IoT in production systems and how this new technology will harmonize the entire process from production to the consumer.

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IoT In Manufacturing

Elsewhere, IoT is increasingly being applied in the manufacturing processes across many factories and producers. Companies have heavily invested in the manufacturing sector, resulting in a massive increase in manufactured goods and services. However, in an increasingly competitive global market, reducing the cost of production and manufacturing goods and services with efficiency is of utmost importance to manufacturers. Companies have invested heavily inefficient production systems in ensuring they have the edge over their competitors. The digital revolution is aiding producers to improve their production systems by reducing production time, improving the quality of products, and reducing production costs.

Commerce has been fully integrated and migrated onto the online platforms to what is now e-commerce. The full application of IoT in commerce has forced companies to migrate their manufacturing systems to IoT to enable a seamless business flow from production to consumption. Motivated by the success of IoT in the supply chains and other applications and the need to improve on efficiency, manufacturers have migrated from the traditional modes of production to IoT-based production. This process involves scheduling presentations to optimize productivity based on specific objective functions of the company (Lin, Kong, Li, Chen, & Huang, 2017). The production synchronization process consists of using edge devices and cloud computing to form a suitable production platform.

To this end, companies, producers, and manufacturers have heavily invested in IoT manufacturing systems. It is estimated that the manufacturing industry invested over $200 billion in 2019, a figure that was double the amount that was spent on the consumer end of the IoT in the same period. Furthermore, the IoT production systems are predicted to grow by over 12% by 2025 ("Internet of things in manufacturing: Benefits, use cases and trends," 2020). Manufacturers have borrowed heavily from the efficiencies experienced through the application of IoT in the e-commerce supply chain. Therefore, they have shifted their focus to implement the same systems in the manufacturing sections to reap the huge benefits that abound from the use of IoT. The application of IoT in manufacturing is called smart manufacturing. IoT-enabled manufacturing provides synchronization of all assets, resources, and production processes. This process streamlines the entire business production leading to optimization of the production processes. IoT in manufacturing synchronizes the production process by inter-connecting all production equipment and integrating all the diverse production processes. This is done by automation of the production process, where all machines and processes are controlled by specific software.

The IoT is a key component in the manufacturing sector. An integrated approach of connecting data, machines, robotics and Information Technology is applied to improve productivity and efficiency ("Internet of things in manufacturing: Benefits, use cases and trends," 2020). In the manufacturing sector, the IoT connects sensors and actuators through digital computer applications to enhance productivity by leveraging IT technology's efficiency. The IoT edge devices are interconnected through an internet protocol, and each device is uniquely identified within the system to receive the correct instructions for production. The IoT in manufacturing applies technological innovation and existing modern communication applications into a single system that greatly increases the production capacity and reduces the production costs.

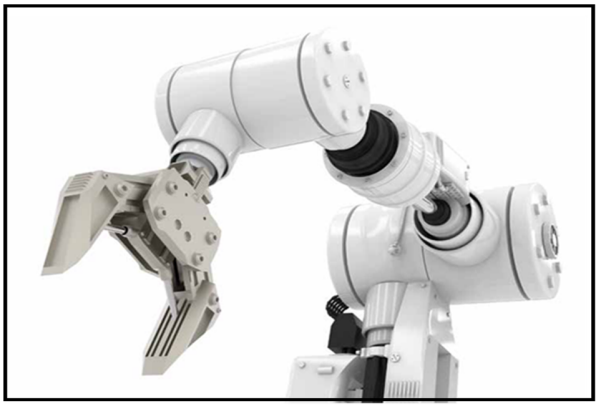

Fig 1.1 Automated Robots in Manufacturing
(Source: Wisskirchen et al., 2017)

The application of IoT in manufacturing has greatly reduced the cost of automating production lines while creating more manufacturing potential for these industries. For instance, programmable logic controls, digital controllers, and commercial PCs have been installed in production lines to replace analogue systems. These digital devices communicate using cloud systems that control the entire production process with minimal human input. Modern IoT systems use open data connectivity with dynamic exchanges that improve production standards. Cloud analytics is applied to ensure proprietary data is channelled through the devices in real-time to control production.

Moreover, sensors are attached to machines, devices, and production processes to allow the company to monitor the process and receive real-time feedback on any issue arising. These analytics from sensors enable the company to improve efficiency and productivity by increasing the company's responsiveness to the process. Consumers,

suppliers, and transporters are given real-time visibility to allow for the timely onset of their specific sections in the production process. IoT system employs intelligent manufacturing that uses advanced digital technologies to achieve smart, reconfigurable, and flexible production processes (Zhong et al. 2017). IoT enables the entire manufacturing system to be readily available at a time and place where it is required across the whole system. This system requires specific technology that enables the different devices to respond to additional requirements. This technology, controlled from a database and transmitted through web applications, communicate directly with sensors in these devices to actuate natural production processes at different stages.

The application of IoT in the manufacturing industry is a game-changer that impacts manufacturing approaches, models, and concepts in the global arena. Modern digital technology is a new manufacturing model that has upgraded production by synchronizing all stages of production into a single system. This production process synchronizes all devices, sensors, decisions, resources, and data analytics automatically. With such synchronization, production efficiency and product quality are improved, leading to enhanced competitiveness of the firm and the ability to adapt to the changing dynamics of the manufacturing sector.

The IoT application leads to the concept of smart manufacturing that adapts new methodologies, models, and forms that transform the manufacturing system from the traditional approach to the more efficient intelligent manufacturing (*Davis, Edgar, Porter, Bernaden, & Sarli, 2012, p 149).* The IoT architecture utilizes internet and cloud technologies to supply integrated customizable and collaborative manufacturing processes. The organizational management of technical and logistical elements of production is thus highly improved.

The increased data-gathering, analytics, and connectivity presented by IoT in modern manufacturing systems have shifted the industry towards an e-commerce economy (*Sniderman, Mahto, & Cotteller, n.d.).* In smart manufacturing, data, physical devices, and internet communication are valuable sources integrated to build smart manufacturing, supply, transportation, and retailing processes. As Sniderman et al. explain, IoT uses embedded technologies and intelligent production processes that utilize modern digital technology, which has completely transformed manufacturing, supply chains, and business models.

IoT synchronizes the physical and digital aspects of manufacturing through networking sensors with physical devices to communicate, analyze, and apply the information to execute the manufacturing process. The IoT synchronizes the rotation of data creation with execution to provide the desired outputs. For instance, the software creates a design for an object which is then communicated to a device for implementation into a physical end product. The data, communication, and the process are captured by the system for analysis and re-execution in the manufacture of the next object. These analytics enable the production process to be systematically reviewed for improvement.

Manufacturing companies have to implement IoT manufacturing to consider the current trends of technology-driven e-commerce *(***Jain, 2017, p.14**). With the increased use of IoT in the supply, distribution, transportation, and retailing chains, manufacturers must equally implement appropriate manufacturing technology integrated into the other IoT-enabled e-commerce systems. The application of smart manufacturing will transform manufacturing, customer interaction, and end-user experiences. Smart manufacturing must therefore be implemented to synchronize manufacturing with the other business chains that are already using smart technologies. The use of information technology impacts business outcomes by transforming the whole business system. Business operations would not be smooth where some parts of the business chain use IoT while others are still languishing in the traditional techniques.

E-commerce provides an efficient and real-time method for companies to receive orders from customers. E-commerce requires an efficient supply process for different amounts and sizes of products (Lin, Kong, Li, Chen, & Huang, 2017). With IoT-enabled demand/supply chains, production must be set in a manner that meets the demand from customers. Companies are forced to synchronize displays with demand orders. This synchronization reduces the logistical problems associated with customer demand and supply processes. This synchronization uses Information Technology and physical internet protocols to coordinate the production, transportation, supply, and delivery of different products from the same source. According to (Lin, Kong, Li, Chen, & Huang, 2017), E-commerce business synchronization uses integrated planning and scheduling decisions to process, monitor, and dispatch products to the required destinations.

IoT has the advantage of analyzing product breakdown frequencies and predicting machine breakdowns using stored production data analytics. This type of information allows the company to prepare for any breakdown, indicate the expected loading of the devices that enable timely planning and scheduling of maintenance. Additionally, the analyzed data allows the company to allocate the necessary resources for each section.

Methodology

The research employed an analysis of existing research writings on IoT. The paper began by introducing the Internet of Things platform and how it operates. The paper then highlights the various application processes of IoT in e-commerce, mainly dwelling on the system's advantages. The research then expounds on IoT applications in manufacturing, analyzing the application procedures, the positive impacts, and synchronizing IoT manufacturing into the e-commerce system.

Results

The research findings conclude that the inclusion of the internet in e-commerce has revolutionized the process to make it one of the most advanced and highest consumers of digital technology. E-commerce has grown in leaps and bounds, where goods and services flow electronically with minimal interruptions. The introduction of IoT in manufacturing has raised the efficiency of the production systems and is increasingly becoming a major recipient of modern computer technology.

The IoT and advances in computer technology, digital applications, and Artificial Intelligence (AI) have necessitated changes in business operations, communications, supply chains, factory operations, and human work patterns. In a nutshell, IoT has significantly replaced traditional human functions, bringing about drastic changes in the way businesses are conducted. New business models have emerged, and the technology has characterized increased quantities and efficiency through automation of the manufacturing processes.

IoT enables many heterogeneous devices to be connected and communicate seamlessly to carry out certain operations on their own (**Kaur et al, 2018, p 5884**). An IoT system comprises physical components, controller service, resources, database, analytical, and applications that interconnect through a web service. These services communicate with each other and complete tasks without any human intervention. Accordingly, IoT systems promote a coordinated flow of information between the devices in real-time by identifying, authenticating, and interacting to complete the tasks (**Zhang et al., 2018, p 421**). This technology is extensively applied in industrial, commercial, and consumer applications. The world has experienced exponential growth in the use of IoT in recent years. A wide range of devices has been connected and controlled through the internet. Though the devices are technologically different, the IoT system creates a synchronized operation by all. The IoT has built opportunities for direct integration of different physical machines into a computer system that has led to improved efficiency, huge economic growth and minimal human exertions (Mattern & Floerkemeir, n.d).

The IoT Architecture consists of three levels or layers that work in synchrony to complete specified tasks. The layers- devices, platforms, and enterprise are interconnected by different forms of internet networks that facilitate a smooth flow of data and information through the three layers. The devices consist of sensors, actuators, and other physical devices that originate or execute a task. The platform layer has an aggregation of data systems that control and process data from the devices using Websockets, edge analytics, and fog computing. The enterprise layer executes the task based on data from the other two layers. These layers utilize direct network communication technologies that shorten the data transfer to real-time, leading to operational efficiencies. The IoT applies network communication, radio frequency identification, cloud computing, and sensors to disseminate, monitor, and manage all applications in real-time (Zhu, 2020).

The tremendous growth and application of IoT-related technologies in many spheres of our lives have increased the opportunities to apply IoT in e-commerce. IoT provides an effective platform for the integration of different aspects of e-commerce to facilitate near-automated process of information flow; supply chain, monitoring, and tracking. The IoT platform has efficient control of the entire chain of a product flow. **Zhu (2020)** reckons that IoT enables efficient product management through optimizing real-time tracking, logistics, and monitoring that influences the quality of products. This system thus helps to promote the development and efficiency of e-commerce across the globe.

The use of IoT in e-commerce has greatly assisted companies in optimizing their operations. IoT applications allow companies to trace and monitor all products along the supply chain in real-time. Moreover, they can optimize logistics and seamless management of all procedures, including supervision, gathering, and recording all related information along the supply chain (**Zhu, 2020**). This is achieved by integrating all stages into an interconnected system controlled by a single web system. The connectivity of all devices along the supply chain to form a single platform reduces the time spent navigating every stage and increases efficiency by eliminating logistical shortcomings. This efficiency has seen e-commerce sales soaring to over $27 trillion in 2020 (Dinesh et al., 2018, pp. 130).

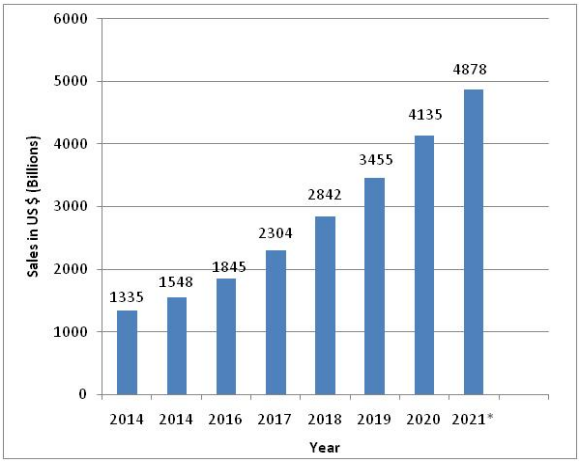

Fig 1.0 E-Commerce sales worldwide from 2014-2021 (Source: Dinesh et al., 2018, pp. 130)

On the other hand, the IoT integrates all the information along the supply chain to make it easy to share and disseminate between the various devices. Information becomes interoperable along with the single IoT platform. This makes it easier to carry out both internal and external analysis of the e-commerce chain while at the same time achieving a unified standard of operation for all products. Thus, every node along the chain can perceive the necessary information within a very short time, allowing it to perform its expected application in real-time.

This information gathering and sharing enable the company to easily analyze the operations and flow of each product from source to the market. An E-commerce system can use available information to improve the potential of the e-commerce system or allow the company to respond to the changing dynamics of the market. The information flow allows the company to control the flow of goods and services from the source to the end-user. Additionally, companies can predict the trends of their products and take the necessary remedies at the earliest opportunity. The role of internet is also vital in education (Alkhunazian, 2021: Khan et al, 2019; Khan et al, 2020).

IoT enables companies to optimize their linear management system that interconnects producers, warehouses, suppliers, distributors, end-users, and all distribution channels involved in the entire system. The IoT system uses modern digital applications to manage the flow of goods through this complex channel easily. The use of the internet and web-based databases reduces the logistical nightmare of interconnecting production with transportation, warehousing, and retailing through the sophisticated global market.

CONCLUSION

In the end, the IoT has brought a drastic shift in the way businesses and manufacturing are conducted. It holds a huge potential for flexibility and increased productivity in the business and manufacturing sectors. The IoT has brought about production/business customization and better quality processes and products. Companies can now cope with production challenges by analyzing data that the IoT readily avails at every stage of production. Moreover, IoT enables efficient utilization of available resources by eliminating wastages, synchronizing production cycles, and applying intelligent processes. The IoT and other AI technology applications have given manufacturers a unique opportunity to grow their business and integrate it with other e-commerce functions. Profitability could rise tremendously through expanding production efficiency and a seamless flow of products from planning to consumption in real-time. The internet of Things presents a new platform for technology adoption and expansion of production capacities.

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