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Role of RFID in Machinal Process of Manufacturing: A Critical Review of Contemporary Literature

Harikumar Pallathadka[1], Laxmi Kirana Pallathadka[2] and Shoraisam Kiran Singh[3]
[1]Manipur International University, Imphal, Manipur, INDIA.
[2]Manipur International University, Imphal, Manipur, INDIA.
[3]Manipur International University, Imphal, Manipur, INDIA.

[1]Corresponding Author: harikumar@miu.edu.in

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ABSTRACT

RFID (radio frequency identification) is a modern supply chain management technology that is increasingly being used. RFID technology's potential to identify, detect, and monitor data across the supply chain significantly influences logistics and supply chain operations. The system may provide suppliers, manufacturers, distributors, and retailers with accurate, real-time inventory information. This exact stock data would result in lower labor costs, automated company practices, and improved supply chain efficiency. If executed correctly, it may minimize the ordering wait duration and Inventory management costs, improve inventory data quality, help avoid stockouts, and enhance the frequency of stock movements. RFID technology has prompted much debate and supposition over its possible repercussions. RFID is a new technical breakthrough that enables supply chain partners to cooperate closely by providing real-time informational transparency. Mean and T-test is applied in the study to find the result of the study with 193 respondents.

Keywords- RFID technology, Supply Chain Management, smart technologies, manufacturing companies, consumer application.

I. INTRODUCTION

Radiofrequency identification (RFID) technology, an invention that relies on the transfer of information through electromagnetic signals, is one of the most widespread yet exciting wireless technologies that does not need physical touch. Because of its ability to recognize and keep track of individual objects, radio frequency identification, or RFID, is being used in various fields. These fields include aerospace, architecture and building administration, healthcare, electronic commerce, transportation, and surveillance. Radiofrequency identification (RFID) technology enables industrial organizations to accomplish speedy monitoring and transparency since it handles produced things, resources, and operations openly. This makes the technology ideal for supply chain management. RFID has quickly become an important driving force not just in manufacturing but also in supply chain operations. The management of supply chains, often known as supply chain management (SCM), is becoming more difficult and unpredictable. It is anticipated that both RFID and the Internet of Things will play significant roles in the supply chain process of satisfying the expectations of customers. Even though RFID technology has been available for quite some time, it has only recently begun attracting the attention of businesses and academic institutions. The reason for progress is that the individual components of this technology have become more effective, less expensive, and smaller as time has gone on. This has made the technology simpler to implement in various settings. RFID is a wireless communication medium that, in its most basic form, has the potential to be used as system interfaces for sensing, recognizing, differentiating, recording, and analyzing a variety of different things. The advantage of using RFID is that it can connect the informational realm to the physical domain and discover the relationship between

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things that exist in the physical and information space. Automatic Identification and Data Capture (AIDC) is a subset of this technology, and it allows for the simultaneous scanning of many RFID tags via a wireless link. Many different industries use the technology of RFID for a wide variety of purposes, including the compendium of congestion charges, the tracking of general merchandise inventories, the traceability of supply chains, the tracking of library books, the prevention of theft, the availability of chair-lifting, the system of system of vehicle immobilizers along with the recognition of railway rolling stock, and the mobility of monitoring. The Internet of Things and RFID (Radio Frequency Identification) has received significant attention throughout this investigation. Topics covered include the technologies' development over time and their capacity to combine elements of innovation, augmentation, and supply chain management. Radio Frequency Identification technology in business and consumer settings is expanding quickly. This technology has the potential, but it has not yet been realized in its full potential. The system administrators have access to a wealth of opportunities, as it is their responsibility to satisfy customers' requirements and prerequisites and offer assistance to customers in integrating a Radio Frequency Identification solution into a Management Information system network. Executives in businesses that deal with large-scale information analysis should consider the most recent technological developments since these advancements can be valuable to their organizations. Up to this point, the most recent technology has made its mark on the retail industry and supply chain management systems. Implementing this technological advance in the industrial industry has not yet been successful, but it is anticipated that it will be in the future. This technology has emerged as a leading invention across various sectors, including manufacturing, for the creation of automated systems. For every tagged item that can be tracked, the technology generates a one-of-a-kind identifying number that complies with international and worldwide standards. Currently, manufacturing and industrial organizations are looking into automating their distribution systems to serve their production needs better. RFID plays a vital role in improving automation in industrial systems. Many challenges develop in the manufacturing business that consists of tracing real-time data and its process that monitors items. These issues are based on the conventional system, and many of these concerns exist. Because of this, there is no way for a system to be automatically updated to carry out additional required processing if different choices must be made according to the appropriate objects. Radio Frequency Identification technology is a mechanical gadget that aids in easing the process of conquering such challenges as they already exist. Combining flexible manufacturing equipment to transmit allotted instructions to a consistent gadget is possible.

Ding & Jiang (2018) stated that Under industry 4.0, RFID (Radio Frequency Identification) technology is widely deployed in production units. RFID technology simplifies and increases the transparency of the industrial process. Meanwhile, it generates more production data, often disparate, uncorrelated, and challenging to utilize. The physical structure and operational logic of IoT-enabled smart job-shop manufacturing are analyzed in the paper. The author has developed an RFID-based production data model to sanctify and correlate diverse production data. Recent RFID-based production data analysis triggered by an event is anticipated to construct RFID events and assess the execution of process commands. The research aims to provide an understanding of RFID-based production data analysis for production management in smart-job shops enabled by IoT. RFID-based large-scale production is mined for information, knowledge, and rules invaluable for real-time production and decision-making. The IoT-enabled division of smart workshops is detailed alongside the creation of RFID devices and other IoT devices. RFID enables real-time production control and the optimization of production decision-making using different suggestions derived from past production data. The demonstration data's feasibility and efficacy have been confirmed for the suggested model and methodologies. Finally, remaining issues and future work for advancing the prosed model and methodologies were mentioned. RFID is a well-known and widely used technology in industrial and other sectors. RFID, or Radio Frequency Identifying, is an identification technology that enables the transmission of data between "RF Tags (or Data Carriers)" carried by an individual or connected items and "Antenna (or Reader/Writers)." The RFID system is a radio communication technology used for various applications. Utilizing RFID technology improves the aggregation and management of things and information. Radio Frequency Identification's principal purpose includes applications such as job training and history management.

Chaudhuri et al. (2018) concluded that in the food sector, it is crucial to track the historical context and localization of commodities in order to guarantee quality as well as stability across the food chain. RFID technology is used in the meat-processing sector to establish product authenticity. Additionally, some significant firms in customer-bundled product management demand that their suppliers embed RFID tags in palettes or containers to optimize warehousing, inventories, and personnel security.

According to Caizzone & DiGiampaolo (2015), RFID technology is being utilized to handle several hospital areas in the health sector. RFID technology regulates processes, such as plasma donations, to find sufficient blood sacks for a particular patient. RFID technology is used to gather data on the mobility of trauma victims.

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Abdirad & Krishnan (2021) stated that monitoring the location of components in a manufacturing chain is a popular RFID technology application. For example, in manufacturing robots, incorporating an RFID chip allows gathering data on the accompanying duties. Infineon Technologies, one of the world's top semiconductor producers, has developed an authentication and segmentation system based on RFID and ultrasonic sensors to improve logistics in the wafer production phase.

II. LITERATURE REVIEW

Zeba et al. (2018) examined and concluded that the manufacturing industry faces intense rivalry from adversaries and high client expectations. Industry 4.0, as a new production framework, mandates its requirements. The fundamental impetus of Industry 4.0 is the emergence of new technological innovations, such as communication and information technologies, which have accelerated the advancement of automatic data-gathering systems. RFID is one of the main innovations for industrial automation, including current information and manufacturing technologies. Even though RFID technology is employed in Croatia, it is not widely used in industries where the major challenge of poor performance is triggered by a lack of inventive competencies and old technological equipment. In order to achieve this goal and increase competition, the industry needs to expand the use of RFID technology as the basis for digitalization. The study has two objectives: to give a bibliometric academic assessment of RFID technology and to illustrate the benefits of RFID technology from the perspective of industrial automation, emphasizing the Croatian sector.

Costa et al. (2013) concluded and evaluated that the present growth of the Internet of Things (IoT) supports improvements in contemporary industry, energy, agribusiness, and transport, in addition to opening up creative possibilities in gaming, amusement, and home automation. Furthermore, wirelessly integrating persons, things, and machines deliver tremendous technological and commercial potential in many industrial sectors. Real-time surveillance of manufacturing infrastructure and procedures using RFID passive technology is a relevant and usable tool. It is now feasible to implement sophisticated wireless sensor networks precisely into items in production or across equipment and machinery, thanks to new perceiving ICs. RFID technology's pervasiveness provides novel surveillance frameworks and methodologies in which the networks are re-configurable, the number of acquisition sites is highly extensible, and single-use applications are viable. In addition, physically integrating RFID sensors in items makes it feasible to construct smart objects capable of autonomously interacting with the external environment during their entire existence, from manufacture to validation through in-use and disposal.

According to Liu et al. (2017), a Just-In-Moment (JIT) production system is a manufacturing strategy that produces what is needed at the correct time and in the appropriate amount. When a demand comes at a phase, this mechanism allows for the prompt creation of a new portion of that stage. The Kanban management system is a well-known 'pull' control method. A Kanban is a 'visible card' that acts as a management and information device in the production and assembly processes to regulate the material flow and optimize the Work-In-Process (WIP) stocks. This study initially explored the significance of real-time automated gathering of shop-floor field measurements during production implementation and current RFID technology breakthroughs in this area. The theoretical paradigm was given to facilitate the development of WM solutions. A case study shows how the suggested RFID-based Kanban system may be implemented in a specialized manufacturing scenario, such as a product assembly line. RFID-based Kanbans are well-suited for adaptive production management and control because of their accessibility as well as transparency of real-time information. Adaptive decision-making and better-organized assembling processes can improve product assembly, part fabrication efficiency, and reliability on shop floors. This study's sole objective is to demonstrate how RFID technology may be used in Kanban-based shop floor administration. Actual manufacturers must participate in identifying and evaluating benefits.

Tzeng et al. (2008) concluded and stated that the RFID system is a very steamy as well as helpful innovation in manufacturing as well as supply chain management that is anticipated to substitute bar-code in stock command, management of materials, dispersion network, online payment since a minimal cost RFID tag is competent in terms of reading or writing details of an enterprise without body interaction, has a quick identification pace, and has a considerably larger storing competence when especially when compared to bar-code. RFID readers link to back-end databases using radio frequency signals in car identification systems. This technology, which has been available for some time, has the potential to be used in a wide variety of disciplines. Though not devoid of flaws and problems, it is a feasible technology that academics expect will become prevalent in the following years, assisting businesses with supply chain management, surveillance, interpersonal identification, and asset tracking issues. This study aims to apply this innovation in manufacturing planning and supervision in the case of a discrete production mechanism requiring real-time control of the manufacturing process and improve production management level effectiveness and dependability.

Rafique et al. (2016) researched and found that contemporary manufacturing shop floors have congestion in capturing and gathering real-time field data. Mechanical paper-based methods are time-

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consuming, error-prone, laborious, and prevalently destroyed, stolen, or forgotten. As a result, the data does not accurately represent real-life conditions and changes because of disruptions. It is hard to make appropriate shop floor judgments lacking up-to-date information. This study describes a low-cost strategy for improving shop-floor performance by fabricating wireless devices, an upcoming futuristic production innovation. For the gathering and synchronizing of actual field data from production workplaces, WM heavily leans on wireless technologies such as RFID or auto-ID sensor systems, as well as wireless information networks. The reliance is on how to use WM technology to manage work-in-process (WIP) inventory in the manufacturing industry facilities with standard operational designs. This method prevents switching from streamlined to intracellular patterns to maintain operational agility while increasing throughput and effectiveness. Sample WIP logistic operations will be utilized to show how manufacturing and logistic workers and their administrators complete their jobs on a WM shop floor. If wireless manufacturing factory platforms are to exceed expectations, additional scientific research is required. The readiness level of RFID technology also has many challenges related to its implementation as its progress is being made in its fully integrated technology in pre-present manufacturing functions. In recent times, many researchers in industry and academics have discussed different methods of using Radio Frequency Identification that help improve the efficiency of carrying out manufacturing functions as a steady transition in the 4.0 era.

According to Raut et al. (2020), lean manufacturing is one of the most popular strategies in manufacturing organizations due to its strong performance in improving organizational effectiveness by decreasing inefficiencies. Lean production is one of the major conceptual frameworks for rapid and efficient manufacturing. However, its effective deployment is a priority owing to various hurdles that affect agile and may be overcome when RFID technology is used. With this in mind, this investigation aims to educate and offer a comprehensive literary analysis that can demonstrate how Lean manufacturing based on RFID helps overcome hurdles to lean production in consideration of existing studies. The goal of this comprehensive research study is first to identify the challenges to lean adoption and then to describe the qualities of Lean manufacturing based on RFID that is highly practical for overcoming those obstacles. Lean manufacturing based on RFID qualities like functional transparency, inventory management, manufacturing management, reduced response time, and data in real-time is particularly beneficial in controlling these hurdles. The uniqueness of this study is the clarification offered to academics and researchers by mentioning and applying past research that unquestionably reveals the favorable benefits of RFID on lean deployment. Nevertheless, in the future, RFID complexity difficulties may be addressed by incorporating the newest functions, such as "RFID integrated cloud-based systems," which have evolved as a significant perspective in the IT world and may be highly advantageous to assist RFID-based lean manufacturing. Moreover, various technology-enhanced lean deployment strategies may be provided in the future to reduce interoperability concerns and accomplish correct initial commitments.

Khayyam, Ramish, Ur Rehman & Syed (2022) revealed that the primary purpose of the work is to concentrate on implementing RFID technology in supply chain management in developing nations. Wide-range of literature and communication with industry experts reveals that businesses in developing nations need more understanding and knowledge of RFID technology and its application in business. Knowledge and understanding of RFID technology and its adoption is preventing industry experts in developing nations from trying to experience new methods of the operating supply chain. Culture is at the top of the list of obstacles in implementing Radio Frequency Identification. Inadequate infrastructure and a lack of industry-capabilities awareness are the reasons for the dearth of knowledge and insight. Academic notions need to be sufficiently integrated into industrial processes. There is an urgent need to close the knowledge gap between academia and industry. Understanding, education, and guidelines about the advantages and application of Radio Frequency Identification technology, its adoption, and implementation in the supply chain would be fine. There must be guidelines and set action plans for industry experts along with a strong framework based on dynamics specific to the industry to assist, guide, and encourage industry experts to make them experience innovation and creativity in the supply chain. This part of the study concentrates on the retail industry, and researchers can explore other industries in the near future.

III. OBJECTIVES

1. To ascertain the role of RFID in the manufacturing process.
2. To identify the importance of RFID in the manufacturing process.

IV. METHODOLOGY

The study is empirical. The number of participants was 193. For data collection, a structured questionnaire was used. The outcomes of the study were analyzed using the mean as well as the t-test. The technique of sampling used was sampling at convenient times.

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V. OUTCOME

Table 1 depicts the Respondent's gender; male respondents are 54.92%, while females are 45.08%. When looking at Age, those between 28 and 35 years old make up 39.90%, those between 35 and 40 years old make up 35.75%, and those above 40 years old make up 24.35%. Regarding the types of industries, automobiles make up 21.24%, textiles make up 17.10%, food and beverages make up 29.53%, and other industries make up 32.13%. Concerning the Designation, the percentage of Unit Managers is 27.46%, the percentage of Production Managers is 24.35%, the percentage of Transport Managers is 20.21, and the percentage of others is 27.98%.

Table1. Respondent's Demographic Details

Variable	**Number of respondents**	**Percentage %**
Gender		
Male	106	54.92%
Female	87	45.08%
Total	**193**	**100 %**
Age		
28 to 35 years	77	39.90%
35 to 40 years	69	35.75%
More than 40 years	47	24.35%
Total	**193**	**100 %**
Industry type		
Automobile	41	21.24%
Textile	33	17.10%
Food and Beverages	57	29.53%
Other	62	32.13%
Total	**193**	**100 %**
Designation		
Unit Manager	53	27.46%
Production Manager	47	24.35%
Transport Manager	39	20.21%
Others	54	27.98%
Total	**193**	**100 %**

Table 2: The role played by RFID in the mechanical process of manufacturing

Sr. No.	**Survey Statement**	**Mean Value**	**T-Value**	**Sig.**
1.	RFID makes easy the process of supply chain management and logistics	4.13	15.975	0.000
2.	RFID helps in providing accurate data on work-in-progress	4.23	17.499	0.000
3.	Paperwork gets reduced by the utilization of RFID.	4.19	17.199	0.000
4.	It allows supply chain workers to work together and offer actual time knowledge of work.	4.10	15.577	0.000
5.	RFID helps in identifying the root cause of any damage caused during production work or other manufacturing flaws	3.73	10.507	0.000
6.	It recognizes, detects, and monitors the data along with the supply chain.	3.41	5.802	0.000
7.	It reduces the ordering wait period and inventory management expenses and improves inventory data quality.	4.01	14.428	0.000
8.	RFID collects data on the mobility of trauma victims	4.29	18.509	0.000
9.	RFID helps the organization in tracking the manufacturing process in an easier way	4.12	15.877	0.000
10.	It enhances the warehousing, inventory, and security system of personnel.	4.20	17.308	0.000

Table 2 displays the mean values for "RFID's role in mechanical manufacturing processes." RFID makes the process of supply chain management and logistics simpler (mean = 4.13) is the first statement of the T-test, followed by a statement about providing precise WIP data (mean = 4.15). RFID aids in delivering precise data about ongoing work (mean value 4.23). The third assertion is the decrease in paper use in the task: "The use of RFID reduces paperwork" (mean value 4.19). Next is the cooperation of employees and the provision of real-time, accurate information. "It enables supply chain workers to collaborate and provide real-time knowledge of work" (mean value: 4.1), "RFID helps in identifying the root cause of any damage caused during production work or other manufacturing flaws" (mean: 3.73), "It recognizes, detects, and monitors the data along with the supply chain" (mean: 3.73), and "It identifies, detects, and monitors the data along with the supply chain" (mean 3.41). It minimizes ordering wait time and inventory management costs and improves inventory data quality (mean 4.01). RFID captures data on the mobility of trauma sufferers (mean value 4.29), and RFID assists organizations in more easily monitoring the production process (mean 4.12). It improves employee storage, inventory, and security

(mean 4.20). In the context of RFID's involvement in the mechanical production process, the t-value of each comment in the survey is noteworthy since the t-value of each statement is positive and more than 0.05.

VI. CONCLUSION

RFID has many applications, including supply chain traceability, congestion charge compendium, vehicle parking access control, general merchandise inventory tracking, chairlift availability, library book tracking, robbery avoidance, vehicle immobilizer systems, railway rolling stock recognition, and mobility monitoring. RFID and IoT have been thoroughly analyzed, including their evolution through time and the use of both technologies to enhance SCM. RFID technology is being rapidly used for a wide range of business and consumer applications. The actual capability of this technology has yet to be realized. There are many opportunities for systems administrators who must aid in integrating RFID-based solutions into enterprise-wide Management Information Systems networks. This cutting-edge technology can bring value to any business engaged in large-scale information analytics, regardless of its specific application. The invention has earned its name in retail and supply chain management. It will only be a matter of a few years until its production application reaches saturation.

RFID is a cutting-edge technology used in the supply chain and manufacturing industries because it can recognize, detect, and monitor data and significantly impact the supply chain's logistics and operations. RFID technology delivers real-time inventory data to suppliers, wholesalers, manufacturers, and retailers. Accurate stock data aids in reducing labor costs, automating company practices, and enhancing production efficiency and the supply chain. RFID is a novel technology that can reduce inventory management costs, order wait time, and increase inventory data quality. Appropriate use and implementation of technology aid in minimizing stockouts and accelerating stock movement. Acceptance and deployment of radio frequency identification technologies have sparked much debate and speculation over their potential outcomes. It is an emerging technology that allows supply chain and production employees to collaborate and gives real-time transparency and knowledge of operations.

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