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Smart Manufacturing Technology Adoption for Improving Productivity: A Systematic Literature Review

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Abstract. This paper is to present a review of the Smart manufacturing application as Industry 4.0, specifically on the conceptual approaches to define it. Two conceptual approaches to the application of the concept of smart manufacturing are distinguished. The method using the previous articles of scientific journals from 2017-2022 (thirty-two international paper) were selected based on previous works, with the scope to investigate and analyze in-depth the extent to which literature used to discuss results in the selected studies of applying the Smart Manufacturing Technology in manufacture enterprises. The results of the previous studies are discussed and investigated in a table format.

Keyword: Smart Manufacturing, Industry 4.0, Review

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1. Introduction

Nowadays Internet of Things, Artificial Intelligence (AI), Analysis of Big Data and Robotization are the technological trends in manufacturing which are transforming industrial processes [1]. These processes are known as the revolution of fourth industrial, Industry 4.0 or smart manufacturing [1].

The competition for leadership in new technology industries is not new in recent economic history. Just as in the 1950s and 1960s competition was for the steel, machine and tool industry, in the 1970s for the semiconductor, electronics and hardware industry and for the Internet in the 1990s, for manufacturing based on robots, artificial intelligence, and digital platforms [2].

Global competition in manufacture industry has intensified as a result of a cycle of investment and international trade of low dynamism, the slowdown in the expansion of value chains due to the effect of China [3]. (Higher cost) and reshoring towards advanced economies (automation effect), and, the technological advances associated with the digitalization of production, the development of cloud services and artificial intelligence. Of particular importance are the effects on the labor market of this accelerated convergence [4].

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These technologies already used for several years are potentiates to modify the manufacturing industry with fully integrated, optimized also automated production scheme; and significant impact to improve the performance and productivity of the organizational [5].

Research by Menon [5] argued that three global advanced manufacturing factories – North America, Asia and Europe – led by the United States, China and Germany are projected. China was the most competitive country in manufacturing, followed by United States in the second position, while Germany, in third as stated by Deloitte's Global Manufacturing Competitiveness Index. Such changes in competitiveness form three dominant clusters competing for progressive manufacturing supremacy, where the cost can be replaced by digital automation through the deployment of the Industrial Internet [6,7].

Thus, this research aims to review the application of smart manufacturing the benefits and implications in manufacture enterprises likewise, distribute how these and their manufacturing technologies can assist to transforming productivity of the company, especially in the small and medium-sized enterprises context about the importance of moving to industry 4.0 for competitiveness, and remain in the global competition.

For this end, a review of the conceptual framework on some considerations are presented in this regard. Based on this, the research questions asked are: What is smart manufacturing? What are the technologies associated with smart manufacturing? And, what benefits and implications for SMEs.

2. Theoretical Review

In the world, coronavirus pandemic already speeds up the spread of digitalization at a time when there have already been important of technological advances based on Industry 4.0, such as Internet of Things, Robotics, and AI [8].

The function of application technology in Industry 4.0 for manufacturing is to increase productivity and to minimize environmental impact that can establish more occupation than it substitutes. Meanwhile, Industry 4.0 influence productivity of firms in another sectors, which has an effect on outlook for industrialization dan structural modification in developing countries, which is key to development and the reduction of diversity within and between countries [9].

The rapid development of automation technologies has revived concerns about worker replacement and the threat of structural unemployment. The automation of cognitive tasks, which until recently could only be performed by qualified experts, is made possible by the decrease in computational processing and storage costs and by the extraordinary progress made in artificial intelligence technologies, in particular in the large-scale machine learning and deep learning on fields [10].

2.1. Concept of Industry 4.0

Industry 4.0 point to intelligent and integrated production systems that make fresh technologies possible, especially with the upgrade the use of automation and data exchanges. Smart manufacturing integrates and controls of parameter production using equipment and sensor connected to digital system with the support of artificial intelligence [11].

Based on the approaches proposed by Sukhodolov at 2019, Industry 4.0 is defined as a new industrial model for the self-organization and self-management of fully automated production systems, which learn autonomously and are interactive [12]. The core is modern digital and Internet technologies, and the skill of humans is limited to their inception, control and technical maintenance, which requires new skills of modern industrial specialists and is accompanied by shifting in social [12].

Although the term emerged in the manufacturing field, Industry 4.0 directly influences each sector and industry, in such a way that the interaction between digital and physical technologies and, in general, the capabilities offered by Industry 4.0 are not limited to improving the beginning, development and end of the supply chain, rather, they contribute to profit growth, product development and transformation, and the customer experience itself [13].

Big Data and Cloud Computation are considered as data services, which use the data generated in the implementation of Industry 4.0, and are not independent components [14]. Globally, manufacturer companies which adopt Industry 4.0 expected to have larger productivity gains than others. Simultaneously, skilled workers may be better prepared for the modification to intelligent production and be less adversely influenced by changes in job and tasks [15]. Industry 4.0 technologies may be initially making the economies' performance much better in exports of high skilled technology and employment [8].

Technological cycle has a deeper and larger impact than introduction of a gradual or common technology. It changes the way how people relate to others and to the environment, and requires intimate companies' changes [9].

The four main specific feature of Industry 4.0 are: (1) Vertical integration of intelligent production systems; (2) Horizontal integration across global value chain networks; (3) Complete engineering throughout the value chain; and (4) Acceleration of manufacturing [8].

The term "Industry 4.0" is used to denote the transformation process in global value creation chains. Sukhodolov at 2019 state that Industry 4.0 with business processes in the manufacturer that contemplate the company of global production networks based on original information and communication technologies, and Internet which the interaction of production objects is carried out. Industry 4.0 is a golden age of industrial manufacturer, organized on the basis of digital technologies and automated [11,12].

There are some equipment component that can work from computer which is include recent robot for industrials, cobots (new type of robots that collaborate with people that can friendly reprogrammable and used in many manufacturer industries for humans and that are easily reprogrammable and are used in various industries for several tasks, such as package the goods, palletizing and automated machine system, industrial tools in a manufacturer industries), intelligent automated computer, three-dimensional printers for traditional manufacturing and less technologically advanced machinery [16].

Digital networks, as well as the Internet of Things for Industry, link traditional machine and tools with sensors, equipment and actuators, allowing them to record, transmit and analyze on data related to the production processes. Simultaneously, these components create a networked system designed to perceive, make predictive decision and communicate with the physical world for assisting the real-time production [4,14].

2.2. The Industrial of "Internet of Things" (IoT)

Internet of Things in Industrial is organized into three main pillars: link the networks, cross industry platforms and vertical specialization, where various that are at other levels of development meet. These include linked networks, Internet of Things for Industrial, robotics, additive manufacturing, artificial intelligence systems, cloud computer, big data analysis and storing [19].

The Internet of Things in Industry (IIoT) can communicate between all devices internal and external of the factory. IIoT is a non-specify and open system in which self-organized smart entities and virtual things are interoperable and able to act freely by determine its purpose (or shared goals) depending on relation, situation, or conditions [17].

Faced with new challenges such as climate change, increasing inequality and the disruptive impacts of new technologies on employment, developed countries make the structural correction to face this new economic cycle. Examples of these structural corrections are the revival of industrial policy strategies — the Industrial Internet — the strengthening of national innovation systems and the revision of regional cooperation mega-agreements that include digital economy issues — trade, standards and intellectual property [18].

The digitalization of manufacturer production has accelerated in common years as a result of a recent convergence between production process operation (OT) technologies and the Internet of Things in Industrial. During the last five decades, three main phases of convergence, highlighting the most recent where the developments associated with the Internet of Things in Industrial, cloud, big data analysis and robotization have allowed the emergence of a new model of factory, changing the paradigms of the processes of manufacturer, companies and the models of business mainly in the manufacturer sector [21].

The Industrial Internet is an enabler of the structural change of the economy whose development and deployment occur in an ecosystem characterized by the convergence between various technological platforms such as the Internet of Things (IoT), connectivity networks, cloud system, storage and analysis of big data, robotics and artificial intelligence systems, among others [23].

In this transformation process, the basic digital infrastructure is the existing capabilities in the value chain of the Consumer Internet in its different links, highlighting the capabilities in application development, content aggregation, hosting and transport [22]. The development of national industrial Internet capacities will depend on the existing digital base and the effectiveness of public policies for countries to join the value chain of the international industrial Internet [24]. A successful transformation process should be expressed in a vector of disruptive changes – at the level of products and services, processes, new industries, work and industrial organization – to generate impacts on productivity, diversification and sustainability [25].

The main impacts of the Internet of Things in Industrial on the manufacturing factory will be in the growth of virtual reality, robotics, AI and automated learning technologies [26]. These new technologies will play a fundamental part in the constitution of digital manufacturer, in a context of quicker transition from the corporate ICT functions of the factories to the cloud architecture [27]. This process faces several troubles, highlighting the difficulty of the communication between IoT things and cloud system, as well as the latency aspects of communication networks and the security mechanisms applied to manufacturing processes [21].

In the case of the manufacturing industry, the most influential companies on the industrial Internet are Bosch, General Electric (GE), Hitachi Data System, Samsung and Siemens. In these companies – of recognized reputation in the manufacture of machinery, equipment and devices and leaders in industrial automation – technological innovations are made to allow, through applications of IoT, connecting, controlling and monitoring devices using various cloud platforms. Examples of this are the Asset Performance Management and Predix platforms developed by GE and Web of Systems, from Siemens. Intel and Dell stand out in the hardware industry, with the development of a new generation of processors and infrastructure components for IoT [16].

2.3. Smart Manufacturing and Industry 4.0 in Developing Countries

Industry 4.0 technologies need to be raised and make the positive impacts to manufacturer from developing countries. The countries must give an incentive to the manufacturer especially SMEs. This can make the recognized of why they must adopt the digitalization process transformation [4].

Some of the countries already make a move to start the digitalization of manufacturer with partial or fully adoption of Industry 4.0 technology. Meanwhile, there some challenging things that happen related to infrastructures, supporting organizations, a well-skilled based workforce and preparation of the manufacturer [11]. To boost the Industry 4.0 technology, the countries must make strategic things which are contextual and reflect to the main resource mobilization and capacities and levels of manufacturer, infrastructure for digital and technology also with production competence [18].

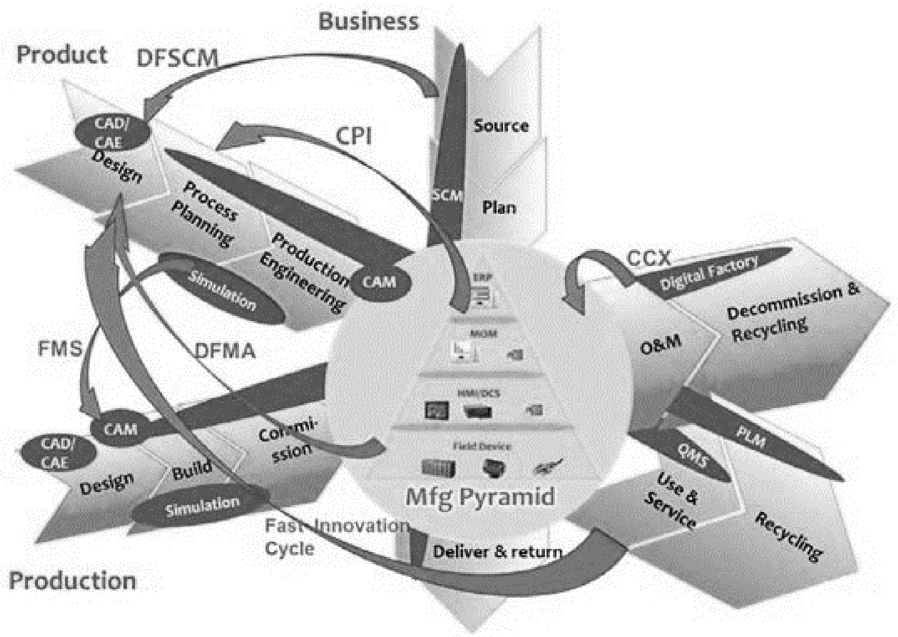

Figure 1 Current Standards Landscape for Smart Manufacturing Systems [14]

The countries will not be able to take full advantage of smart manufacturing for growth if the manufacturer lack of skill and digitalization in manufacturing [17]. If there's no one of these elements, some companies in the countries will be able to use Industry 4.0 technologies and even less manufacturer will be able to adopt the use of smart manufacturing [22].

The countries can also make necessary digital framework for deploying Industry 4.0 for Industrial, including the development of country strategic to guide growth and coordinated deployment; create a multi-stakeholder scheme that institutionalizes approach to develop Industry 4.0; and establish international coordination to accelerate transfer knowledge of technology [23].

Developing countries must planning and acting the procedure to take benefit of Industry 4.0, reduce potential adverse impact over time [17]. The international society can help simplify economic diversification and technology usage by manufacturing organization in the countries [13]. Every phase of technology processes since the industrial changing has been connected with greater inequality between the countries. Previous the nineteenth century, there was some income disparity among the countries; rather, dissimilarity was a matter of internal class divisions [19].

The capability of manufacturer in the countries to deploy Industry 4.0 things directly depends on quality of digital infrastructure in the companies. The countries stakeholders must promote digitalization, high quality speed of the Internets and reduce the range between the small dan large company [21].

2.4. Benefits of Industry 4.0 in Manufacturing

Industrial Internet of Things (IIoT) has come out step by step and linked with the new technology into digitalization and new ecosystem which are used together, tough already affected whole parts of people for years, has much wider gap than the manufacturer process [6].

Industry 4.0 with digitalization system is especially linked to connectivity and communication between people and machinery, which is supposed to modify the design, manufacture, operational and service of the systems. Modification of operations include forecast decision making through Big Data Analysis; minimizing difficulty through upgrade coordination; new type of collaboration, communication and coordination; flexibility in when and where to manufacture the goods and gained digital contribution to companies' productivity, from human judgment to AI [10].

Some countries and minor companies are leading the growth of Industry 4.0 tech [11]. The capacity of manufacturing, research and development of high technology is others fundamental element in the combining of industry 4.0. In this regard, economies can be separate into four broad types, namely, leading economies, second-tier economies, economies lagging economies and economies with late industrialization [28].

Another benefit pointed out by [17] the usage of Industry 4.0 tech for manufacturer can lead to increased productivity, power efficiency and continuously, which are several east countries adopt advanced digital production technologies. These things increase noticeable into every move of production, spotting areas of optimization.

Industry 4.0 technologies also have a good effect on increasing productivity of companies. Companies that keen to use these techs show faster development in the value added of their manufactures. It is important to note that this upgrade in productivity is connecting with an upgrade in employment [22].

Digitalization in industry can even make energy-saving chance by optimizing or replacing the most energy-demanding technologies and introducing energy-efficient optimization the function of business processing. By combining the real-time data management competency into available tools and systems that can lead to continuous improvement and reduce costing for industry [20].

The implementation of Industrial Internet of Things in smart manufacturing process could lead to continuous improvement and reduce inefficient of the energy usage [21].

The upgrade of technology and improvement affect inequality in relation to income, salary and jobs, in linked up reaction throughout the fundamental of economy. As far as Industry 4.0 in Industrial is concerned, updated technologies are mainly formed in process innovation to go up the productivity [14].

Industrial that implement Industry 4.0 tech and introduce new output can make growth of profits than another industry in the same field [24]. The implementation of AI and robots in smart manufacturing can also additional the working positions of expert employee and go up the request for hand of work in less ordinary functions compared to routine job. Because of that, the direct influence of Industry 4.0 is on dissimilarity linked to the productivity of firms around sectors and wage diversity due to changes in occupations and tasks [25].

2.5. Impacts of Industry 4.0 for Small and Medium-Sized Enterprises (SMEs).

A key criterion for an appropriate robust model is its overall appropriate to the industrial structure of small and medium-sized enterprises (SMEs). Many digitization efforts fail due to (1) the low motivation of employees who are sometimes narrow minded; and (2) the complexity and misunderstanding of technological developments [19].

SMEs specifically need initially information on the possibilities of digitalization and then a guide on how to take the first steps towards digital transformation [19]. Therefore, a significant purpose of a robust model is to provide direction to SMEs on how to achieve a next level of robustly in their unique region and keep moving in the right way with their industry strategy. The robust model should permit them to placed their business against outside trends and provide guidance for selecting appropriate technology and smart service options [15].

Finally, the necessary to improve a new industry 4.0 robust model that is useful for SMEs are: analyzing the organizational structure and strategy; change culture and leadership; determine how it meets the needs of the end customer; and establish the technological level within Industry 4.0.

3. Research Methodology

To inquire about the aim of this study in investigating the previous research, as well as find the method applied used, then the document review was chosen as an analytical technique of the related journal publication. To understand the role of smart manufacturing, we conducted a comprehensive literature review, which resulted in the identification and analysis of 322 high-quality published international journals, between 2015 to 2022, which were selected and analyzed.

A table presented in this study to investigate the results of previous studies related to the case of the smart manufacturing. It supposed to be caution that even though the discovered procedures were used during the selection operation, the number of distribution was substantial to analyze all articles and, in particular, the authors analyzed various studies centered on smart manufacturing.

The study was organized into 5 parts. Section 1 contains an establishment that establish about the framework of the crucial and necessary of smart manufacturing technology for the manufacturing industry in the face of global competition in the 21st century. Section 2 explains a review of the literature associated to the concepts with enterprise productivity. Section 3 describes a methodological review of the literature section from various past research such as the implementation of smart manufacturing. The case research analyzed in this article are manufacturing industry companies. Section 4 summarizes the outcome of an alternative of various high-quality international journals established to the application of smart manufacturing which are poured into the table. Section 5 summarizes the results of an analysis of several studies and articles applying smart manufacturing. Finally, the conclusions and future studies from this research are presented in section 5.

4. Results and Discussion

4.1. Identified of Machine Learning Applications on Previous Literature

Sixteen previous studies related to the application of Smart Manufacturing technology that is appropriate to the purposes of this study has reviewed for further analysis. These citations are reviewed in Table 1 as follows:

Table 1 Smart Manufacturing Technologies Applied in Manufacturing Industries from 2017 to 2022.

Authors	Publication Year	Journal	Technology Adopted	References
J. Friederich, D.P. Francis, S.L. Molnar, N. Mohamed	2022	Computers in Industry	Data-driven Digital Twins	[8]
J.O. Sullivan, D.O. Sullivan, K. Bruton	2021	Procedia Manufacturing	Digital Twins	[9]
D. Palade, C. Moller, C. Li, and S. Mantravadi,	2021	Proceedings of the 23rd International Conference on Enterprise Information Systems	• ERP (Enterprise Resource Planning. • OP4SP (Open Platform for Smart production). • MES (Manufacturing Execution System).	[12]
P. Grefen, I. Vanderfeesten, K. Traganos, Z.D. Schmidtand, and J.D.V. Vleute	2021	Machines	RAMI 4.0 (Reference Architectural Model Industry 4.0)	[14]
R.G. Macías, I.S. Marmolejo, I.J.G. Hernández, and J.Z. Silva	2020	International Scientific Journal about Logistics	• RTLS (Real-Time Location Systems) • RFID (Radio Frequency Identification) • TAM (Tool & Asset Manager) application	[15]
M. Zoubek, and M. Simon,	2020	Conference: 36th IBIMA (International Business Information Management Association)	Smart Factory	[16]
YT Dharanendra, V Ashwini, HS Kumaraswamy, and BM Rajaprakash	2019	Manufacturing Technology Today	• Hazardous Gas Detection, Electromyogram (EMG) monitoring system • Machinery health monitoring (MHM) • IoT integrated Radio Frequency	[19]

Authors	Publication Year	Journal	Technology Adopted	References
			Identification (RFID). • IoT integrated Real Time Inventory Management (SCM)	
N. Iftikhar, T.B. Andersen, F.E. Nordbjerg, E. Bobolea	2019	Proceedings of the 8th International Conference on Data Science, Technology and Applications	• Exploratory data analysis (EDA) • Overall Equipment Effectiveness (OEE)	[20]
V.S. Narwane, B.E. Narkhede, R.D. Raut, and I.A. Siddavatam	2019	Industrial Engineering Journal	• Cloud Computing • Computer Aided Design • Computer-Aided Manufacturing	[21]
S.D. Supekar, D.J. Graziano, M.E. Riddle, S. Das, S.U. Nimbalkar, A. Shehabi, and J. Cresko	2019	CIRP Procedia	• Cost of Conserving Energy (CCE) • Cyber-Physical Systems (CPS)	[23]
H.K. Lee and T. T. Kim	2019	ICIC Express Letters Part B: Applications ICIC International	• Digital twin • Internet of Things (IoT) • Internet of Service (IoS) • Big data analytics	[26]
H. Yang, S. Kumara, S.T.S Bukkapatnam, and F. Tsung	2019	IISE Transactions	• Internet of Manufacturing Things (IoMT) • Cloud computing • Rami 4.0	[27]
M. Zheng and X. Ming	2017	Advances in Mechanical Engineering	• Automatic loading and unloading • Digital Logistic Tracking • Automatic faults diagnosis & warming • Real-time monitoring of production process • Welding parameters optimization • Balanced mixed flow production	[29]
M. Abdelhafidh, M. Fourati, L.C. Fourati and A. Chouaya	2017	NeTCoM, CSEIT, GRAPH-HOC, NCS, SIPR	Industrial IoT FDMS (Fluid Distribution Monitoring System)	[30]
J.S. Randhawa and A.S. Sethi	2017	International Journal of Engineering and Management Research	• Computer Aided Design & Engineering • Computer Aided Manufacturing, Computer-Aided Process Planning • The Usage of Computer Numerical Control	[31]

Authors	Publication Year	Journal	Technology Adopted	References
K.D. Thoben, T. Wuest, and S. Wiesner	2017	Int. J. of Automation Technology	• Cyber-Physical Logistics (CPS) System • Safe Human-Robot Interaction • RFID	[32]

Table 1 above reports previous studies that applied the Smart Manufacturing technology into several case studies. All journal included in Table 1 is to indicate that nowadays groundbreaking documents is moving towards advanced topics such as actual data and information management, cloud system and big data analysis powering the bring through technologies and enabling execution of Smart Manufacturing.

Table 2 summarizes the identified enabling technologies of Smart Manufacturing and its contribution or benefits in manufacturing industries, as follows:

Table 2 Smart Manufacturing Technologies Applied and its Contributions in Manufacturing Industries

Application Areas	Technology	Contributions	References
Germany industries	• Cyber-Physical Logistics (CPS) System • Safe Human-Robot Interaction • RFID	Can satisfying changing behavior of customer demands in small scale when integrated human and automation system. To help manufacturer conversion to digitalization process, policy strategic in developing countries which have do research and development technology.	[32]
North India Small and Enterprises Manufactures (SMEs)	• Computer Aided Design & Engineering • Computer Aided Manufacturing & Process Planning • CNC (Computer Numerical Control) Usage	Smart Manufacturing is the most improving if looked at the performance and innovation at the production sided. These upgrading are allowing the deployment of distributed and actual embedded computer systems that can be change into crucial elements to the improvement of smart manufacturing.	[31]
Water and Oil & Gas Distribution System	Industrial IoT FDMS (Fluid Distribution Monitoring System)	Improve monitoring process and allow a actual management and data processing.	[30]
Automotive body-in-white (BIW) manufacturing in China	• Automatic loading and unloading • Digital Logistic Tracking • Automatic faults diagnosis & warming • Actual monitoring of production process • Welding parameters optimization • Balanced mixed flow production • ERP	Integrated Smart manufacturing technologies help realize real-time production management to upgrade the supervise of production system. Integrated system is provided for workshop image, by actual monitoring data sharing and more useful connection and communication, which will support production and management efficiency growth.	[29]
Cybersecurity	• Internet of Manufacturing Things (IoMT) • Cloud computing	Encourage the production process system to a fresh generation of cyber-physical systems for smart production.	[27]

Application Areas	Technology	Contributions	References
	• Rami 4.0		
Steering system of a Car and Water Dams	• Digital twin • Internet of Things (IoT) • Internet of Service (IoS) • Big data analytics	Sustain the manufacturer to handle physical issues quicker by knowing them sooner, forecast outcomes to a much higher level of precision, design and make better things, and, latter better service to their buyer.	[26]
Smart craft brewing in US	• Cost of Conserving Energy (CCE) • Cyber-Physical Systems (CPS)	CCE could have a key energy mark, and data on their impacts is infrequent. This knowledge distance is relevant chance for life cycle engineering organization. While smart manufacturing may upgrade energy productivity at the manufacturing system degree, CPS life cycle energy use to be considered when evaluating the overall energy burden associated with the proposed interventions.	[23]
CNC Lathe machine	• Cloud Computing (CC) • Computer Aided Design & Manufacturing (CAD-CAM)	CC (CAD and CAM) for manufacturer is useful to both buyer and supplier. Buyer to enjoy diversity of the products also they can model and make their own products, while supplier can economize by creating on-demand, lively, green, and smart production. Supplier can directly produce and transfer required files on virtual grade itself with the assist of web-based application. This solves the problem of interoperability of files up to some extent.	[21]
Dolle's Manufacturing Process (Wooden loft ladders) in Europe	• Exploratory data analysis (EDA) • Overall Equipment Effectiveness (OEE)	OEE and performance indicate that production system was improving or not. The improvement that made by smart manufacturing by reducing the machine downtime. The forecast made by the products are quite acceptable in terms of predicting the breakdown stops, as breakdown are a kind of the main cause of production performance going down.	[20]
1. Liquefied Natural Gas and Liquefied Petroleum Gas 2. Microsoft Azure clouds company 3. Bosch company (Inventory management/ Supermarket)	• Hazardous Gas Detection, Electromyogram (EMG) monitoring system • Machinery health monitoring (MHM) • IoT integrated Radio Frequency Identification (RFID). • IoT integrated Real Time Inventory Management (SCM)	• The advantage of Hazardous Gas Detection, Electromyogram (EMG) monitoring system can discover and alerting system over the common tract, it promotes rapid response and precise detection of an alert state and it aids a swift diffusion of the crucial state. • The technology of Machinery health monitoring (MHM) will reduce maintenance cost and improve productivity, and the vibration data acquired from sensor of a 3D printer and the data interpreted in the time frequency domain at MS Azure cloud, where data is kept on the Azure Web App for local and remote access. • The technology of loT integrated Radio Frequency Identification (RFID) can track the flow of information of unrefined substances and products in the production line. Traceability serves precious information of history of a	[19]

Application Areas	Technology	Contributions	References
		manufactured lot which includes: steps performed, relevant process variable and quality controls. • The advantage of loT integrated Real Time Inventory Management (SCM) help Bosch's distributor (Supermarket) to exhibit real time availability of crucial portions. And Andon represents maximum and minimum the amount of parts to be stored and signifies in red when the amount goes above or below, the set limits and these lead to an extensive RFID permitted e-Kanban system. By executing this production system was able to keep track of Auto production schedule / Plan for Operator, as per availability in Super Market.	
Automotive Industry (Assembly of pipes and small parts (seals, rings))	Smart Factory (RFID, AGV	Companies that are suitable for robotics and automation in the automotive, electrical, plastics, machinery and equipment (engineering) sectors have the highest potential to digitize and implement Industry 4.0 elements	[16]
Metal mechanical industry	• RFID (Radio Frequency Identification) • RTLS (Real-Time Location Systems) • TAM (Tool & Asset Manager) application • GPS	1. GPS integrated with the RFID based on TAM application allows traceability in locations internal and external of manufacturer, in addition to ensuring actual stock reliability. 2. Development in the efficiency for data collection of quantity and location. 3. Upgraded in the reliability of the store of the equipment. 4. Upgraded in excess of the history data of the movements of the teams, such as times, dates, locations and each other's.	[15]
European manufacturing industry	RAMI 4.0 (Reference Architectural Model Industry 4.0)	RAMI 4.0, automation for manufacturing and mechanical sector needs to process engineering — can be attributed to industry organization and standardization committees. Thus, RAMI 4.0 brings a shared knowledge for standards and use cases.	[14]
Part Assembly, Production control,	• ERP (Enterprise Resource Planning. • OP4SP (Open Platform for Smart production). • MES (Manufacturing Execution System).	OP4SP for SMEs providing the minimum required enterprise functions and observing their digitization journey	[12]
Large-Scale Smart Manufacturing Facility	Digital Twins	1. Digital Twins help employees and overtime will go beyond employees' implicit knowledge of capital and mode. Fresh staff worker able to get suggestions on how to make a good treatment to assets based on an expandable judgement digital system.	[9]

Application Areas	Technology	Contributions	References
		2. Vendors able to inspect the whole asset maintenance history data of crucial things. Over time it is expected that these data will be conjoined with another data to meet the potency of Digital Twins.	
Assembling a quadcopter drone part	Data-driven Digital Twins	Data-driven Digital Twins can help stakeholders in upgrading profitable judgement in terms of different performance data. Support for such a judgement is possible since data-driven digital twins extract the good science from all collected data, which proves invaluable to stakeholders, and even data -driven digital twins can offer a good platform to adopt agile manufacturing concepts that enable manufacturing companies to act. respond quickly to market changes while maintaining good quality and controlling costs	[8]

5. Conclusion

The idea of industry 4.0 and smart manufacturing are comparatively new and ruminate the inauguration of digital technologies in the manufacturing industry. Which is, the consolidation into the manufacturing environment of technologies such as the internet of substances, mobile computing, the cloud, big data, wireless sensor networks, embedded systems and mobile devices, among others. The manufacturing industry is facing major changes. These changes are leaded by several big inclinations such as globalization, urbanization, individualization, and demographic change. The increase in globally hooked business activities escalates intricacy within manufacturing industry networks, and volatile demand and customized products influence its purpose and production processes. Even though the industry 4.0 and smart manufacturing are having important outcomes; and, it is notable to predispose all types of companies and its early usage is a chance to do business, plenty entrepreneurs have selected to spoiler, without considering the risk that a late adoption process or not doing so represents for their companies, due to the lack of knowledge that still exists around industry 4.0 and smart manufacturing and that it is not yet clear to them, what are the factors that influence their use; In addition, there is still not enough information about its potential, although it has had a strong growth in recent years, which somehow allows us to anticipate that in the short term industry 4.0 and its technologies will replace conventional technologies.

REFERENCES

[1] Glas, A. and F.C. Kleemann, *International Journal of Business and Management Invention*, Vol. 5, No. 6, 55-66, 2016.

[2] Kang, H. S, *International Journal of Precision Engineering and Manufacturing-Green Technology*, 111-128, 2016.

[3] Brettel, M., M. Klein and N. Friederichsen, *48th CIRP Conference on MANUFACTURING SYSTEMS-CIRP CMS 2015*, vol. 41, p. 105-110, 2015.

[4] Howaldt J., R. Kopp, and J. Schultze, in P. Oeij, D. Rus y F. Pot (eds) *Workplace innovation. Aligning perspectives on health, safety and well-being*, Springer Cham, 2016.

[5] Menon, K., H. Kärkkäinen, and L. To. Lasrado, *Proceedings*, vol. 38, 2016.

[6] D. Preil, and M. Krapp, *Annals of Operations Research*, 415–439, 2022.

[7] Lu, Y., K. C. Morris and S. Frechette, *National Institute of Standards and Technology* NIST, 2016.

[8] J. Friederich, D.P. Francis, S.L. Molnar, N. Mohamed (2022), *Computers in Industry* 136, 1 – 13 (2022).

[9] J.O. Sullivan, D.O. Sullivan, K. Bruton, *Procedia Manufacturing* 51, 1523–1530, 2021.

[10] Yıldız, *Journal of Engineering Research and Applied Science*, Volume 10 (2), December, 2147-3471, 2021.

[11] Gerekli, T.Z. Çelik, I. Bozkurt, *TEM Journal*, 799-805, 2021.

[12] D. Palade, C. Moller, C. Li, and S. Mantravadi, *Proceedings of the 23rd International Conference on Enterprise Information Systems (ICEIS 2021)* - Volume 2, p. 707-714, 2021.

[13] Wang, F. Tao, X. Fang, C. Liu, Y. Liu, and T. Freiheit, *Engineering* 7, 738–757, 2021.

[14] P. Grefen, I. Vanderfeesten, K. Traganos, Z.D. Schmidtand, and J.D.V. Vleute, *Machines* 2022, 1 – 20, 2021.

[15] R.G. Macías, I.S. Marmolejo, I.J.G. Hernández, and J.Z. Silva, *International Scientific Journal about Logistics*, 95-101, 2020.

[16] M. Zoubek, M. Simon, *Conference: 36th International Business Information Management Association (IBIMA) At*: (Granada, Spain 2020), 2020, URI: http://hdl.handle.net/11025/42468, ISBN: 978-0-9998551-4-0.

[17] S. Phuyal, D. Bista, and R. Bista, *Sustainable Futures* 2, 1 – 15, 2020.

[18] Ahmadi, C. Cherifi, V. Cheutet, Y. Ouzrout, Engineering Sciences [physics], Mechanical engineering [physics.class-ph] Computer Science [cs] / *Computer Aided Engineering*, 1 – 21, 2020.

[19] YT Dharanendra, HS Kumaraswamy, V Ashwini, amd BM Rajaprakash, *Manufacturing Technology Today*, 42 – 49, 2019.

[20] N. Iftikhar, T.B. Andersen, F.E. Nordbjerg, E. Bobolea, *Proceedings of the 8th International Conference on Data Science, Technology and Applications* (DATA 2019), ISBN: 978-989-758-377-3, p. 392-399, 2019.

[21] V.S. Narwane, B.E. Narkhede, R.D. Raut, and I.A. Siddavatam, *Industrial Engineering Journal*, 1 – 7, 2019.

[22] M.A. Farsi and E. Zio, IJJRS, DOI: 10.30699/ijrrs.2.1.4 , 23 – 34, 2019.

[23] S.D. Supekar, D.J. Graziano, M.E. Riddle, S.U. Nimbalkar, S. Das, A. Shehabi, and J. Cresko, *Procedia CIRP* Volume 80, 699 – 704, 2019.

[24] S. Mittal, M.A. Khan, and T. Wuest, *Proc IMechE Part B: J Engineering Manufacture 2019*, 1342 – 1361, 2019.

[25] L.M. Watzlawek, *11th IBA Bachelor Thesis Conference, July 10th, 2018, Enschede,* (The Netherlands University of Twente, The Faculty of Behavioural, *Management and Social sciences*, p. 1-17, 2018.

[26] H.K. Lee and T. T. Kim, ICIC Express Letters Part B: Applications *ICIC Internasional*, 931 – 936, 2019.

[27] H. Yang, S. Kumara, S.T.S Bukkapatnam, and F. Tsung, *IISE Transactions* Volume 51, 2019, 1 – 27, 2019.

[28] Iyer, *Procedia Manufacturing*, *15th Global Conference on Sustainable Manufacturing 2019*, 21:663-670 DOI: 10.1016/j.promfg.2018.02.169, p. 663–670, 2019.

[29] M. Zheng and X. Ming, *Advances in Mechanical Engineering* 2017, 1 – 17, 2017.

[30] M. Abdelhafidh, M. Fourati, L.C. Fourati and A. Chouaya, NeTCoM, CSEIT, GRAPH-HOC, NCS, *SIPR* - 2017 pp. 01– 11, 2017.

[31] J.S. Randhawa and A.S. Sethi, *International Journal of Engineering and Management Research*, www.ijemr.net ISSN (ONLINE): 2250-0758, ISSN (PRINT), p. 607-615, 2017.

[32] K.D. Thoben, S. Wiesner, and T. Wuest, *Int. J. of Automation Technology*, p. 1 – 12, 2017.