International Journal of Scientific Research in Science and Technology
Print ISSN: 2395-6011 | Online ISSN: 2395-602X (www.ijsrst.com)
doi : https://doi.org/10.32628/IJSRST

Implementation of Industry 4.0 Standard for Product Based Industries

Hitesh Kaikade, Vikram Ambatkar, Chandrashekhar Zade, Tushar Maske, Nitesh Nagdeote, Akshay Kamble, Prof. Pranali Langde
Department of Electronics and Telecommunication Engineering, J D College of Engineering and Management, Nagpur, India

Article Info
Volume 8, Issue 4
Page Number : 397-404

Publication Issue
July-August-2021

Article History
Accepted : 20 July 2021
Published : 27 July 2021

ABSTRACT

Several new breakthroughs, often referred to as Industry 4.0 (I.4.0), have resulted in rapid changes in the industrial environment in recent years, particularly in the fields of digital technology and manufacturing. While various examples of Industry 4.0 deployment in businesses have been documented to date, there is currently no comprehensive structure for the adoption of Industry 4.0 that includes a precise timetable. It is still a current and uncharted topic of research to investigate the many methods of implementing Industry 4.0. With this article, the primary goal is to present the theoretical framework for Industry 4.0 implementation, which will be illustrated through the use of several Industry 4.0 implementation schedules that have been selected. On the basis of material gathered through literature review and analysis of pilot enterprise projects related to Industry 4.0 (case study) that were carried out in chosen firms, the paper was written. The paper provides the essential components of the Industry 4.0 framework as well as the fundamental step of adopting the concept in the enterprise, with particular attention paid to the sequence and time frames of each component. The proposed strategy is intended for researchers and practitioners who are tasked with bringing the notion of Industry 4.0 to life in their organisations.

Keywords: Industry 4.0; framework for Industry 4.0; schedule of implementation I 4.0

I. INTRODUCTION

The global industrial environment has altered significantly in recent years as a result of a series of technology advancements and improvements in manufacturing processes that have occurred simultaneously. The new concept is referred to as Industry 4.0 (abbreviated: I 4.0) [1] and is described as follows: Industry 4.0 is a powerful mix of operational technology (OT) and information technology (IT) in the manufacturing environment. The Fourth Industrial Revolution [2] has resulted in the development of the Industry 4.0 idea as a result of technical advancement. A professor of physics and former head of the SAP board of directors, Henning Kagermann first coined the term "Industry 4.0" in

2011, and it has since evolved into a plan for the development of German industry [3]. Technology advances made during the Third Industrial Revolution are being used to Industry 4.0 in the area of the degree of automation and digitization of production that has already been accomplished [4].

Industry 4.0 is a technological system that includes many innovations referred to as Technology 4.0, including robotics and automation, 3D printing, collaborative robots (cobots), cloud computing, and the Internet of Things, all of which will be implemented on a large scale in smart factories in the future [5, 6, 7, 8]. It is built on cyber-physical systems, which are enabled by technologies such as the Internet of Things (IoT), the Internet of Services (IoS), Big and Mining Data [7], and artificial intelligence (AI). Because of the active development of CPPS, we are seeing an increasing number of self-improving devices and things [8, which is a form of artificial intelligence]. Production processes that are intelligent in nature are created through the use of technology 4.0, which allows them to independently communicate information, initiate activities, and control one another [9]. For enterprises [10], including SMEs [11], the Fourth Industrial Revolution is the way to increasing competitive advantage.

The concept of Industry 4.0 is being applied progressively in firms through investment initiatives that are being implemented in segments in specific areas of operation [12]. Although there has been some discussion about how to apply Industry 4.0 in enterprises, there has not yet been a complete and concise description of the process in the literature [13]. Individual investment initiatives relating to the Industry 4.0 concept are not described in any publications (even those giving ready-made scenarios and instructions) addressing their implementation [14]. The selectivity with which technology solutions typical of Industry 4.0 are implemented can be observed in both manufacturing businesses and specific industries [15–17]. Studies conducted by PwC and Deloitte in London, UK, [18,19] found that there are industries where technological development is realised more quickly and easily, as well as industries where it is more difficult to apply innovative solutions. Among the first is light industry, which includes industries such as food processing, clothing manufacturing, and the manufacture of household appliances, while the second group includes heavy industry, which includes industries such as metallurgy, mining, and process industry, which includes industries such as the fuel and energy industry [20]. It is also important to note that the effects of the modifications brought in enterprises vary. For example, in production where the end result is e.g., electricity, chemicals, or fuels, improved control over processes as well as increased energy efficiency are achieved [21, 22]. Because of the flexible adjustment of the production scale in factories located in various countries [22], discrete and hybrid production, such as the production of vehicles by automotive companies or production in the food and beverage sector, benefit from the changes by improving product customization (personalization) and shortening delivery times.

Therefore, the research intends to illustrate the general path taken by firms to Industry 4.0 and to construct the stages of work carried out by the surveyed enterprises in order to achieve the level of Industry 4.0 as described in the research. The study was based on an examination of investment initiatives undertaken by chosen businesses that were deemed to be benchmarks in their respective industries. The work's content is a variety of variations on the stages of achieving the next tiers I 4.0 by businesses. All of the above-mentioned company development alternatives represent the authors' scientific contribution to the creation of information about the way businesses operate with the goal of changing their businesses into Smart Factory. The practical component of the work consists in presenting the anticipated time frame for completing specific stages of work in firms (using a case study) [23] [23]. The companies that have been provided do not reflect a representative sampling of all of the companies in a certain industry. Their decision was influenced by the availability of information on the duration of projects in the field of Industry 4.0 at the time. It is possible to grasp the concept of Industry 4.0 from a practical perspective by studying the actions described in the document on the implementation of Industry 4.0 as well as the schedule of projects that have been completed in enterprises.

At the moment, considerable changes are taking place in the requirements for manufacturers. With an increasing number of variants and a reducing batch size, it is important to have a shorter response time, all the way up to individualization of products. Companies who do not have cutting-edge technology will find it challenging to achieve these requirements. Technology 4.0 enables the creation of new, intelligent factories that make items that are tailored to the individual [24,25]. [26–32] Some of the key technological innovations, collectively referred to as "technology 4.0," include:

- a new system of communication in which both the digital world and the real world are connected with each other, allowing for digital information exchange between machines, products in different processing stages, systems, and people—all of whom have an individual IP address—throughout the Internet protocol; direct communication between decentralised systems; and direct communication between decentralised systems.
- Incremental manufacturing technologies, for example, 3-D printing, are carried out in stages in stages, and breakthrough changes are and will be triggered by the scale of their application, synergy, integration, and development dynamics;
- data processing in the cloud or fog, with response dynamics at the millisecond level; analytics; Technology that simulates the operation of real items in their virtual representations, based on data provided and processed in real time, and that allows for the testing and optimization of production process configurations prior to implementing physical changes;

II. MATERIALS AND METHODS

The Materials and Methods should be given in sufficient detail to allow others to duplicate and build on the results that have already been published. Please keep in mind that the publication of your work entails the obligation to make all materials, data, computer code, and protocols related with the publication available to the public on the Internet. Please make any limitations on the delivery of facilities or information known at the time of the submission process. In contrast to well-established procedures, new methods and protocols should be presented in full, with appropriate references to the original source material.

Using the main databases of Web of Science—WoS—and Scopus, as well as other publications, a review of scientific papers was carried out in order to gain knowledge about the methods of implementing Industry 4.0 in enterprises. The review was carried out using the web browser: google.com to find scientific papers.

The investigation was conducted in two stages: first, Science-related papers in two major scientific databases: Web of Science and Scopus Using Google.com, you can get an overview of public publications such as reports, case studies, commercial offers, reviews, and news, among other things.

This is the study question: How do firms execute investment projects towards Industry 4.0—step by step, i.e, the path taken by enterprises to Industry 4.0 and how long each project takes—search for timetables—and how long does each project take?

The ultimate outcomes of the research were as follows:

(1) A broad framework for the deployment of Industry 4.0 was developed.

(2) The fundamental path (route) that businesses will take to achieve Industry 4.0.

(3) A calendar of operations for businesses that will lead to the implementation of Industry 4.0.

This paper included Figure 1, which depicted the strategy that the writers employed from the planning stage through to the conclusion. The authors conducted a bibliometric study as well as a selection analysis, which involved looking for information that was readily available to the public through the use of a web browser. The results of the conducted analyses were utilised to build a broad framework for the implementation of Industry 4.0, a step-by-step guide for firms on their journey to Industry 4.0, and project timetables for individual enterprises. The information offered here is the authors' scientific contribution to the advancement of knowledge in the field of Industry 4.0.

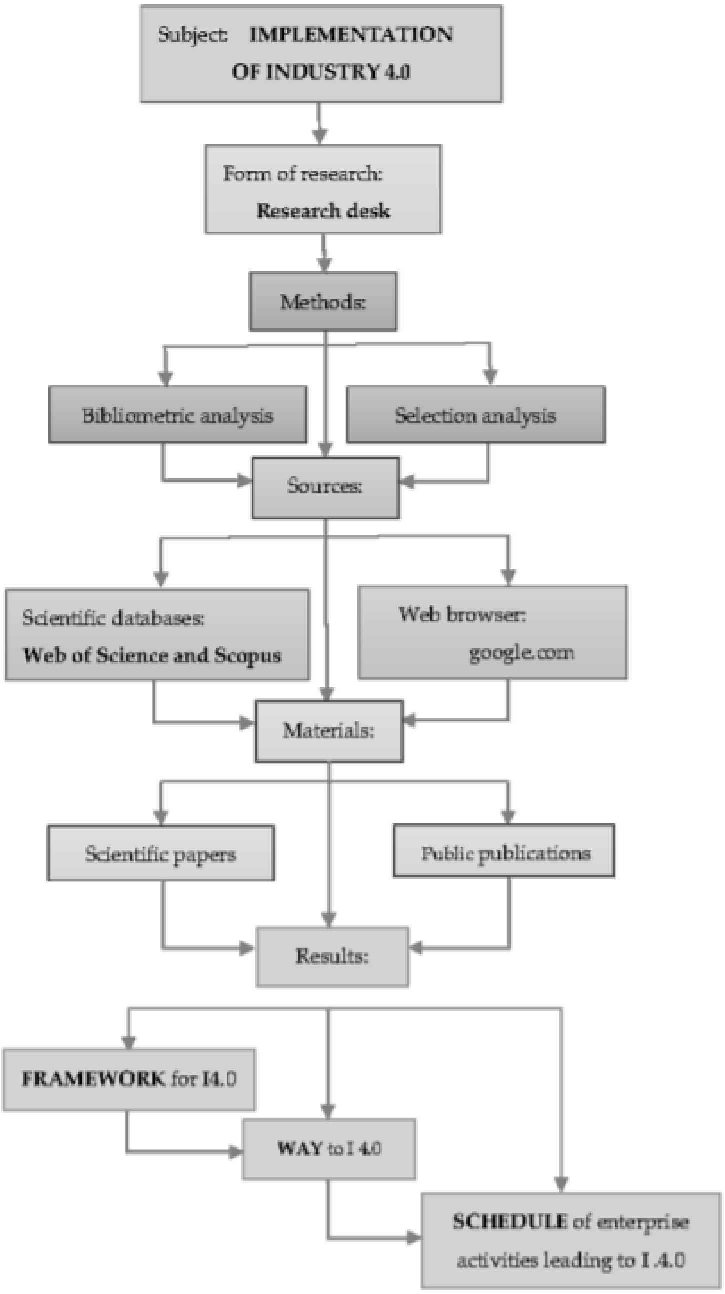

Figure 1. Diagram of the research being carried out.

III.RESULTS AND DISCUSSION

The technological projects of enterprises leading to Industry 4.0 on the operation level are surrounded by knowledge management and new organization culture based on cooperation people and machines. The structure of the key fields is presented in Figure 2.

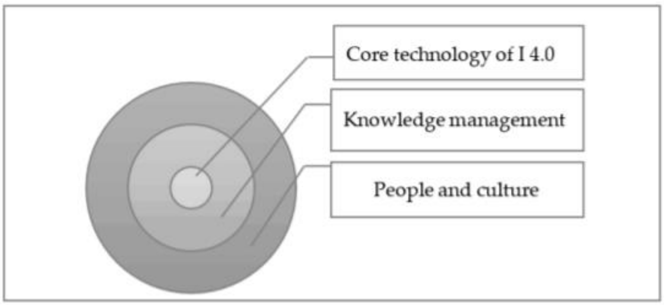

Figure 2. General fields on the way to Industry 4.0.
Source: own study

When executing investment projects in network systems, producers must ensure that they are connected to partners along the whole supply chain. Quality, uniqueness, energy efficiency, safety, cleanliness, aesthetics, and invisible products should be the primary emphasis of mini and micro-producers in order to get a competitive edge in their immediate environment with low environmental impact. The McKinsey report proposes three different plant configurations based on the systems:

Process automation plants (producers) are totally automated, digitalized, and extremely cost-efficient, and they meet the demand for low-cost mass production. These facilities produce in vast quantities and with a wide range of goods.

(2) Customer-centric plants target markets that are on the rise. In order to address the trend toward mass personalisation, these are ultra-responsive factories that produce highly personalised items at a large scale and at a reasonable cost.

(3) The e-plant in a box is designed to target niche and remote markets. It is possible to create a limited assortment of flavors at a new location with this small-scale, low-capex mobile factory, which can be set up fast to satisfy subscale niche markets."

According to project management methodology, the actions of firms in the direction of Industry 4.0 should be separated into two categories: organisational and technology activities. Organizational transformations are carried out in accordance with the Deming cycle (PDCA), and the administration of specific activities is carried out in accordance with the principles of system functioning. In order to maximise the success of a project, it is required to employ optimal approaches, which involve the selection of rules that are beneficial in terms of the manner in which a certain job or operation is performed, and which are referred to as management methodologies. The steps in the process of implementing Industry 4.0 initiatives always include planning, which is preceded by analysis and audit, followed by execution, checking, and adjusting the project's outcomes. Project management necessitates the establishment of a feedback loop, which includes the verification of the assumptions established in the plan of action as well as the implementation of adjustments on a continuing process (project cycle management).

As part of this preparation process, it is essential to raise employee awareness of the value of Industry 4.0 solutions for the company's development as well as a new working culture in order to ensure that projects are successfully implemented across the organisation (culture Industry 4.0). When developing a new organisational culture, the most important question to ask is to what extent the organisational culture will be able to absorb modern engineering technologies. An examination of organisational culture openness to innovation includes the following factors: employees' technological/technical competences, their level of empowerment and satisfaction, their level of technical culture, and their ability to use modern technologies, as well as the engineering development systems they use.

In order to successfully implement the Industry 4.0 strategy, personnel will need to acquire new skills. For example, data gathering and analysis, which includes expertise in the fields of big data and machine learning, are two of the most important. In addition, new competencies and new specialists will be required in the areas of data security, access control, and information management, among other things. The changes have an impact on a wide range of staff competencies. New talents are a frequently brought up topic in debates among corporate professionals, policymakers, and members of the academic community.

Computer settings and cloud-based systems create a backup in case of future modifications.

Industry 4.0 projects are built on the foundation of digitization (Figure 3). Company-specific processes (stages) for implementing Industry 4.0 have been identified based on the web pages of information technology companies. Data is the building block of digitalization. The information is incorporated into the communication system. The first step entails the establishment of production lines—machines—that are capable of exchanging data (thus the requirement for digitalization in companies pursuing the Industry 4.0 development strategy). Enterprises can become more intelligent as a result of digitalization. Machines generate a great amount of data and records, which is why businesses must have sufficient massive storage systems to accommodate this volume of information. The majority of businesses create numerous databases, such as accounting (financial), CRM, MRP, or ERP, as well as databases on their websites, among other things. Everything is dependent on the type of data and how it is used (so-called relational and non-relational databases). The communication system refers to the manner in which machines communicate with one another and exchange information with one another.

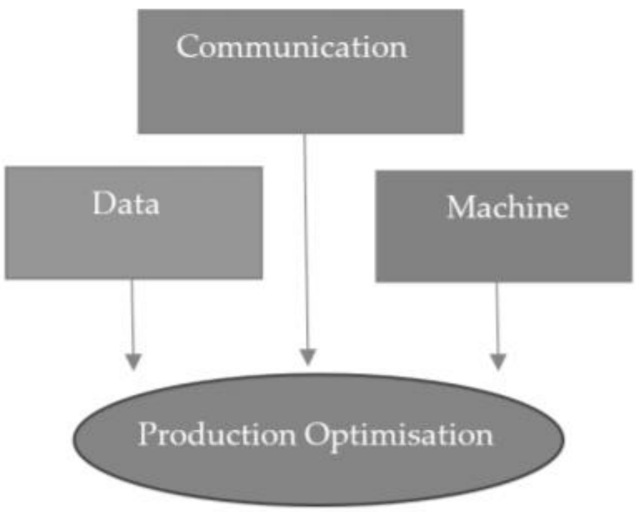

Figure 3. Key components of the project

Using a programming interface (Programming Interface), businesses can communicate with a variety of databases as well as devices and apps of various types. Essentially, these programmes serve as connectors between different documents and devices that generate data (they are in the middle and do not generate data themselves, meaning they do not have their own data). These are programmes that allow you to search for information in databases or other linked devices.

The following step is to define the range of activities that can be performed by machines and by people (machine operators of equipment owners). It is necessary to assign new responsibilities to the machines in order for Industry 4.0 to be successful. It is critical to conduct implementation projects that are based on determining what machines are doing, because machines will be given new responsibilities in Industry 4.0 (and will be able to replace humans), such as data analyst, performance review of other machines and people's job. In cyber-physical systems, there is still a human being present—an operator—outside of the machinery. The function of operators is demonstrated in models that emphasise the significance of humans in Industry 4.0. Technically skilled operators with methodological skills, attitudes toward teamwork, and individual attitudes at the beginning of the transition to full industry 4.0 are extremely active participants in the newly developed cyber-physical systems. Figure 3 depicts the structure that was created by combining the data from the fields.

IV. CONCLUSION

An overall framework for the application of the notion of Industry 4.0 is provided by the strategy that has been outlined. It enables you to create your own route for transforming your company into a smart factory and identifies potential areas of investment for the successful application of the idea of Industry 4.0 in your organisation. It is hoped that this paper will serve as a starting point for more in-depth research on how to implement the concept in industrial companies of various industries. Aside from that, additional research must be conducted in order to identify significant investment areas in firms that are interested in efficient implementation of the Industry 4.0 idea.

V. REFERENCES

[1]. Kagermann, H.; Wahlster, W.; Helbig, J. (Eds.) Recommendations for Implementing the Strategic Initiative Industrie 4.0: Final Report of the Industrie 4.0 Working Group. Industrie 4.0:

Mit dem Internet der Dinge auf dem Weg zur 4. Industriellen Revolution; VDI-Nachrichten: Frankfurt, Germany, 2011.

[2]. Kagermann, H.; Helbig, J.; Hellinger, A.; Wahlster, W. Recommendations for Implementing the Strategic Initiative Industry 4.0: Securing the Future of German Manufacturing Industry. Final Report of the Industry 4.0 Working Group Forschungsunion. 2013.

[3]. Kagermann, H.; Wahlster, W.; Helbig, J. Final Report of the Industrie 4.0 Working Group; Acatech-National Academy of Science and Engineering: München, Germany, 2013.

[4]. Kagermann, H. Change through Digitization—Value Creation in the Age of Industry 4.0. In Management of Permanent Change; Springer: Berlin/Heidelberg, Germany, 2015.

[5]. Schuh, G.; Potente, T.; Wesch-Potente, C.; Hauptvogel, A. Sustainable Increase of Overhead Productivity due to Cyber Physical-Systems.

[6]. Haller, S.; Karnouskos, S.; Schroth, C. The Internet of Things in an Enterprise Context. In Future Internet Symposium; Springer: Berlin/Heidelberg, Germany, 2008; pp. 14–28.

[7]. Oks, S.J.; Fritzsche, A.; Möslein, K.M. An Application Map for Industrial Cyber-Physical Systems. Ind. Internet Things 2017, 62, 21–45.

[8]. Bauernhansl, T.; Hompel, M.; Vogel-Henser, B. Industrie 4.0 in Produkten, Automatisierung und Logistik; Springer Fachmedien: Wiesbaden, Germany, 2014.

[9]. Brettel, M.; Friedrichsen, N.; Keller, M.; Rosenberg, M. How virtualization, decentralization and network building change the manufacturing landscape. An Industry 4.0 Perspective. Periodical 2014, 8, 37.

[10]. Vrchota, J.; Volek, T.; Novotná, M. Factors Introducing Industry 4.0 to SMES. Soc. Sci. 2019, 8, 130.

[11]. Moeuf, A.; Lamouri, S.; Pellerin, R.; Tamayo-Giraldo, S.; Tobon-Valencia, E.; Eburdy, R. Identification of critical success factors, risks and opportunities of Industry 4.0 in SMEs. Int. J. Prod. Res. 2020, 58, 1384–1400.

[12]. Lee, J.; Bagheri, B.; Kao, H. Research Letters: A Cyber-Physical Systems architecture for Industry 4.0-based manufacturing systems. Manuf. Lett. 2015, 3, 18–23.

[13]. Schmidt, R.; Möhring, M.; Härting, R.-C.; Reichstein, C.; Neumaier, P.; Jozinovi´c, P. Industry 4.0—Potentials for Creating Smart Products: Empirical Research Results. Int. Conf. Bus. Inf. Syst. 2015, 208, 16–27.

[14]. Zhou, K.; Liu, T.; Zhou, L. Industry 4.0: Towards Future Industrial Opportunities and Challenges. In Proceedings of the 2015 12th International Conference on Fuzzy Systems and Knowledge Discovery (FSKD), Zhangjiajie, China, 15–17 August 2015; pp. 2147–2152.

[15]. Santos, K.; Loures, E.; Piechnicki, F.; Canciglieri, O. Opportunities Assessment of Product Development Process in Industry 4.0. Procedia Manuf. 2017, 11, 1358–1365.

[16]. Berger, R. Industry 4.0—The New Industrial Revolution—How Europe will succeed; Roland Berger Strategy Consultants: Munich, Germany, 2014.

[17]. Młody, M. Personalizacja produktów a Przemysł 4.0—ocena słuszno´sci implementacji nowoczesnych technologii w przemy´sle produkcyjnym z perspektywy konsumentów. Ekonomika i Organizacja Przedsi¸ebiorstw 2018, 62–72.

[18]. Deloitte-Industry 4.0. The Industry 4.0 Paradox. Overcoming Disconnects on the Path to Digital Transformation, Deloitte Insights, 2018 Deloitte Development LLC.

[19]. PwC-Global Industry 4.0 Survey. What We Mean by Industry 4.0/Survey Key Findings/Blueprint for Digital Success, PwC 2016.

[20]. Hu, S.J. Evolving paradigms of manufacturing: From mass production to mass customization and personalization. Procedia CIRP 2013, 7, 3–8.
[21]. Kumar, A. From mass customization to mass personalization: A strategic transformation. Int. J. Flex. Manuf. Syst. 2007, 19, 533–547.
[22]. Wang, Y.; Ma, H.S.; Yang, J.H.; Wang, K.S. Industry 4.0: A way from mass customization to mass personalization production.
[23]. Adv. Manuf. 2017, 5, 311–320.
[24]. Saniuk, S.; Grabowska, S.; Gajdzik, B. Personalization of Products in the Industry 4.0 Concept and Its Impact on Achieving a Higher Level of Sustainable Consumption. Energies 2020, 13, 5895. [CrossRef]
[25]. Fogliattoa, F.S.; da Silveirab, G.J.C.; Borensteinc, D. The mass customization decade: An updated review of the literature. Int. J. Prod. Econ. 2012, 138, 14–25.
[26]. Grabowska, S. Business model metallurgical company built on the competitive advantage. METAL 2016. In Proceedings of the 25th International Conference on Metallurgy and Materials, Brno, Czech Republic, 25–27 May 2016; pp. 1800–1807.
[27]. Hermann, M.; Pentek, T. Design Principles for Industrie 4.0 Scenarios: A Literature Review; Working Paper, No. 01; Technische Universität Fakultät Maschinenbau: Dortmund, Germany, 2015.
[28]. ermann, M.; Pentek, T.; Otto, B. Design Principles for Industrie 4.0 Scenarios. In Proceedings of the Annual Hawaii International Conference on System Sciences, Koloa, HI, USA, 5–8 January 2016; pp. 3928–3937.
[29]. Schwab, K. The Fourth Industrial Revolution. World Economic Forum. Deloitte. 2016.
[30]. Holtgrewe, U. New technologies: The future and the present of work in information and communication technology. New Technol. Work Employ. 2014, 29, 9–24.
[31]. Stock, T.; Seliger, G. Opportunities of Sustainable Manufacturing in Industry 4.0. Procedia Cirp 2016, 40, 536–541.
[32]. Saniuk, S.; Saniuk, A.; Cagá ˇnová, D. Cyber Industry Networks as an environment of the Industry 4.0 implementation. Wirel. Netw. 2019, 1–7.
[33]. Saniuk, S.; Saniuk, A. Challenges of industry 4.0 for production enterprises functioning within Cyber Industry Networks. Manag. Syst. Prod. Eng. 2018, 4, 212–216.
[34]. Kuhn, A. On the way towards Industry 4.0: Solutions from the top cluster it's OWL—Intelligent Technical Systems East Westphalia-Lippe | [Auf dem weg zu industrie 4.0: Lösungen aus dem spitzencluster it's OWL—intelligente technische systeme ostwestfalenLippe]. ZWF Zeitschrift fuer Wirtschaftlichen Fabrikbetrieb 2015, 110, 8.
[35]. Norton, M.J. Introductory Concepts in Information Science. 2001.
[36]. Polanco, X. Infométrie et ingénierie de la connaissance. In Les Sciences de L'information Bibliométrie Scientométrie Infométrie; Noyer, J.M., Ed.; Presses Universitaires de Rennes: Rennes, Germany, 1995.

Cite this article as :

Hitesh Kaikade, Vikram Ambatkar, Chandrashekhar Zade, Tushar Maske, Nitesh Nagdeote, Akshay Kamble, Prof. Pranali Langde, " Implementation of Industry 4.0 Standard for Product Based Industries", International Journal of Scientific Research in Science and Technology (IJSRST), Online ISSN : 2395-602X, Print ISSN : 2395-6011, Volume 8 Issue 4, pp. 397-404, July-August 2021.
Journal URL : https://ijsrst.com/IJSRST2183110