International Journal of Advanced Smart Convergence Vol.13 No.2 267-275 (2024)
http://dx.doi.org/10.7236/IJASC.2024.13.2.267

IJASC 24-2-32

Application of Smart Factory Model in Vietnamese Enterprises: Challenges and Solutions

Quoc Cuong Nguyen[1], Hoang Tuan Nguyen[2], and Jaesang Cha[3,#]

[1]*Assistant Professor, Faculty of Engineering, Dong Nai Technology University, Bien Hoa City, Vietnam*
[2]*Dong Nai Institute for Innovation, Dong Nai, Vietnam*
[3]*Professor, Dept. of Electrical and Electronic Eng., Chiba University, Japan*
E-mail: nguyenquoccuong@dntu.edu.vn

Abstract

Smart factory is a remarkable development from traditional manufacturing systems to data-based smart manufacturing systems that can connect and process data continuously, collected from machines, production equipment to production and business processes, capable of supporting workers in making decisions or performing work automatically. Smart factory is the key and center of the fourth industrial revolution, combining improvements in traditional manufacturing activities with digital technology to help factories achieve greater efficiency, contributing to increased revenue and reduce operating costs for businesses. Besides, the importance of smart factories is to make production more quality, efficient, competitive and sustainable. Businesses in Vietnam are in the process of learning and applying smart factory models. However, the number of businesses applying the pine factory model is still limited due to many barriers and difficulties. Therefore, in this paper we conduct a survey to assess the needs and current situation of businesses in applying smart factories and propose some specific solutions to develop and promote application of smart factory model in Vietnamese businesses .

Keywords: *Industry 4.0, Smart factory, Cyber-Physical Systems, Industrial Internet of Things.*

1. Introduction

At present, due to globalization and the continuously changing market competition according to the customers' demands, the Industry 4.0 production philosophy can be applied to provide the required quantity and quality of the final products. Science and politics have to work together to establish the Industry 4.0 concept in practice. That means that in the production sector, a complete restructuring of production processes is needed and the current analog, centralized workflow has to be transformed into digital, decentralized production processes. At the same time, the Industry 4.0 concept offers new business models, new products, and new services. All of these transformations are based on internet-driven self-controlling and sensor-aided production systems, thanks to increased programmability, connectivity using Internet of Things (IoT) [1, 2],

Manuscript Received: May. 20, 2024 / Revised: May. 27, 2024 / Accepted: June. 3, 2024
Corresponding Author: chajaesang@gmail.com
Tel: *** - **** - ****
Professor, Dept. of Electrical and Electronic Eng., Chiba University, Japan

memory storage capacity for Big data, and sensor-based capabilities. The development of novel digital technologies connected to the IoT, along with advances in artificial intelligence and automation, is enabling a new wave of innovation in manufacturing [3, 4]. Smart factory is one of the most typical leaps when it comes to the 4.0 Industrial Revolution. A new model is opening up for the manufacturing sector with the rise of more advanced, optimized and sustainable factory configurations. There are many multi-dimensional perspectives, each "smart factory" concept brings different factory forms. The smart factory is a flexible system that can self-optimize performance across a broader network, self-adapt to and learn from new conditions in real or near-real time, and autonomously run entire production processes [5]. Beside, the smart factory is a concept used to describe the application of different combinations of modern technologies to create a hyper flexible, self-adapting manufacturing capability. Smart factories are an opportunity to create new forms of efficiency and flexibility by connecting different processes, information streams and stakeholders (frontline workers, planners, etc.) in a streamlined fashion [6]. Smart factory initiatives might also be referred to as “digital factory” or “intelligent factory.” The smart factory is designed according to sustainable and service-oriented business practices. These insist upon adaptability, flexibility, self-adaptability and learning characteristics, fault tolerance, and risk management. Within modular structured smart factories, cyber-physical systems monitor physical processes, create a virtual copy of the physical world and make decentralized decisions as shown in Fig.1.

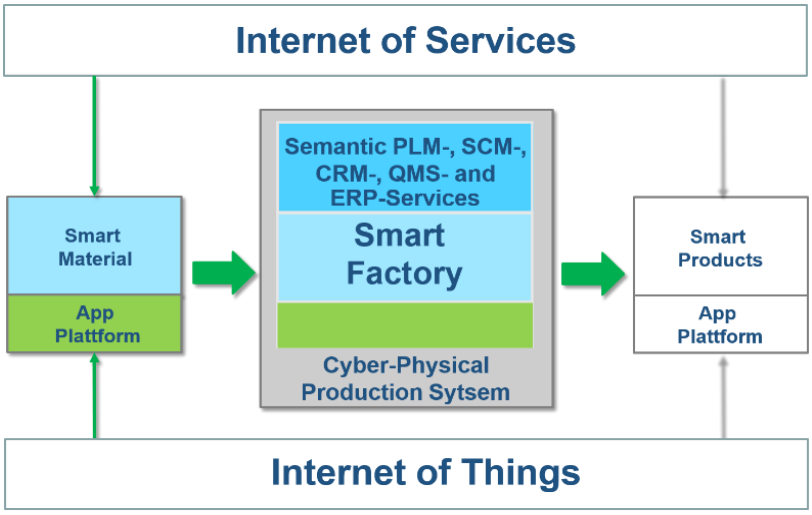

Figure 1. Concept of smart factory

Smart factory solutions allow businesses to meet the increasingly diverse and complex needs of the market. Create unique, high-quality products to increase competition and attract new customers. Investing in smart technology also helps businesses adapt to market changes and attract highly specialized labor resources. According to some analysts, smart factories will drive a new industrial revolution that has the potential to seriously disrupt incumbent companies [7]. Smart Factories will result in production being more flexible, custom-oriented, sustainable and able to utilize resources more efficiently. Consequently, Smart Factories will be self-organizing, more competitive and optimize their own manufacturing activity [8, 9].

Vietnam is a country that is in the process of industrialization, modernization, and international integration. Industry 4.0 opens many opportunities in improving its technology level, production capacity, and competitiveness in the product chain; creating a significant change in the service business form. Industry 4.0

also presents challenges to many specific industries and fields. These include requirements for technological innovation in information technology; analysis and management of big data to create new knowledge, support decision making, and create competitive advantages; renewing of management models and optimizing business models; establishing supply chains and intelligent logistics in the global value chain and new tariff models; developing intellectual property management system for the digital age; and ensuring safety and security of network information systems [10]. The development of a smart factory requires the application and integration of advanced technologies such as artificial intelligence, the Internet of Things, and robotics. Unlike factory models in the world, factories in Vietnam face many specific infrastructure difficulties. In addition, the "low" level of technological maturity is also a barrier that makes it difficult for Vietnamese factories to "customize" foreign models to successfully apply them to their facilities. With many unique characteristics in infrastructure, technology, processes, and people, the "smart factory" suitable for Vietnamese businesses is a model with good interaction in real time continuously. in both directions, from the strategic layer to the management layer, the operations layer, the machinery and equipment layer, and vice versa compared to the traditional factory model - information is often broken between layers is shown in Fig.2.

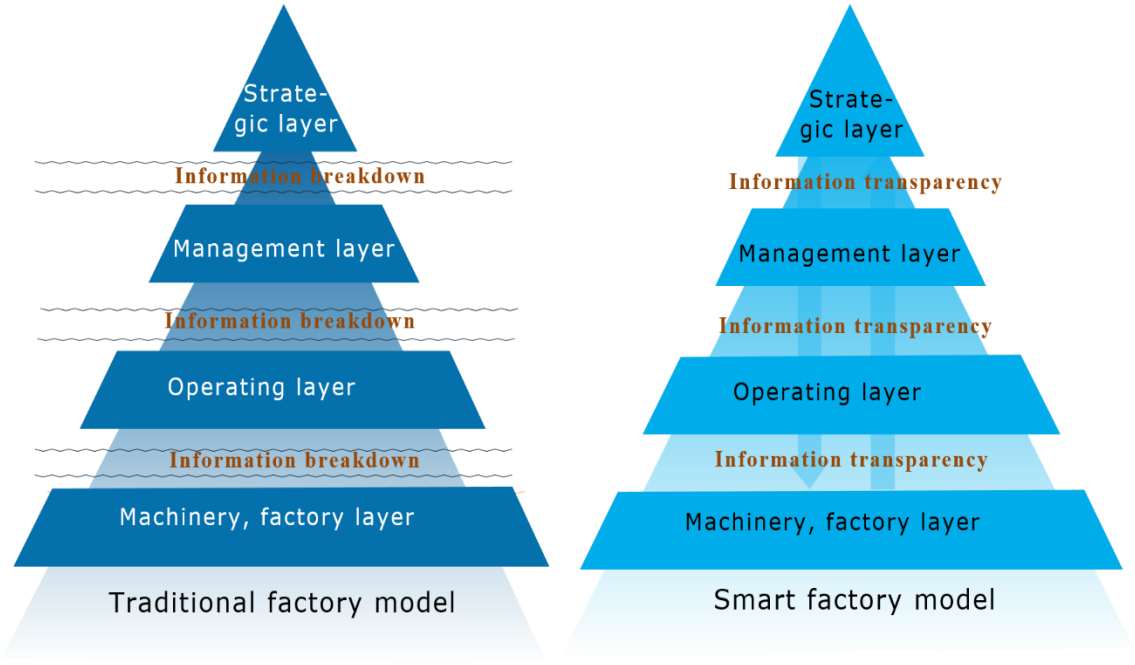

Figure 2. Compare traditional factory models and smart factory in terms of information transmission between layers

Vietnam has a great chance to apply smart factory in the manufacturing sector [11, 12]. Using these factories helps businesses optimize their management systems, analyze production data to optimize production processes, detect product defects, reduce waiting times, reduce manufacturing errors, and increase productivity, and create competition in the market. However, businesses also face many challenges to solve such as problems of technology, human resources, and infrastructure, will help enterprises. This paper will focus on analyzing the current status of application of smart factory as well as proposes solutions to develop smart factory for enterprises in Vietnam.

2. Methods

The authors conducted a preliminary survey of 120 enterprises in the northern, central, and southern provinces on the current situation and the ability to apply smart factory in Vietnam. In addition, based on domestic and foreign references, companies provide solutions for smart factories, the survey is conducted based on 4 benefit factors: improving of the operational, increasing labor productivity, improving of product quality, reducing of material waste and 4 challenge factors: lacking of human resource, deployment cost, technological solution and cyber security [13, 14].

3. Results and Discussion

The survey results are presented in Table 1 and Table.2 with classification of number of employees and classification of Manufacturing Industry, respectively.

Table 1. The survey results for classification of number of employees

Classification of number of employees	Frequency	Rate (%)
1. < 50	14	11,6
2. From 50~ 100	20	16,6
3. From 100~ 500	26	21,6
4. From 500~ 1000	30	25
5. From 1000~5000	20	16,6
6. > 5000	10	8,3

Table 2. The survey results for classification of manufacturing industry

Classification of Manufacturing Industry	Frequency	Rate (%)
1. Food and Beverages	15	12,5
2. Textiles and Clothing	27	22,5
3. Leather and Leather Products	18	15
4. Chemicals	20	16,6
5. Machinery	25	20,8
6. Rubber, Ceramics Products	15	12,5

Based on the results of the survey questionnaire, the advantages and disadvantages of implementing the smart factory model are shown as follows.

3.1 Benefits in smart factory development

As per the survey data, about 82% of the enterprises that participated in the survey agreed or completely agreed with the view that smart factory played a role in improving the efficiency of production line's operation. Smart factory extends to connect all factory operations and facilitates businesses to operate with intelligence at fingertips. From resource allocation to logistics management and business processing, devices and

procedures are connected via internet, data is captured and cloud software platforms are equipped to enable intelligent timely actions for effective operations management. Only 8% of the respondents said that smart factory did not improve this efficiency at all as shown in Fig. 3(a).

And 72% of surveyed respondents agreed or strongly agreed with the point that smart factory played a role in increasing product quality (52% of survey respondents fully agreed with this view), while 2% of the enterprises said smart factory did not play an essential role in improving the quality of product as show in Fig. 3(b). Also, in Fig. 3(c), 65% of survey respondents agreed or strongly agreed that smart factory played a role in increasing labor productivity (25% of survey respondents fully agreed with this view), while 64% of the respondents agreed or strongly agreed that smart factory played a role in reducing material waste (36% of survey respondents fully agreed with this view) as shown in Fig. 3(d). Besides, 64% of the surveyed respondents agreed or strongly agreed with the idea that smart factory played a role in reducing labor costs (27% of survey respondents fully agreed with this view) as shown in Fig.3 (c).

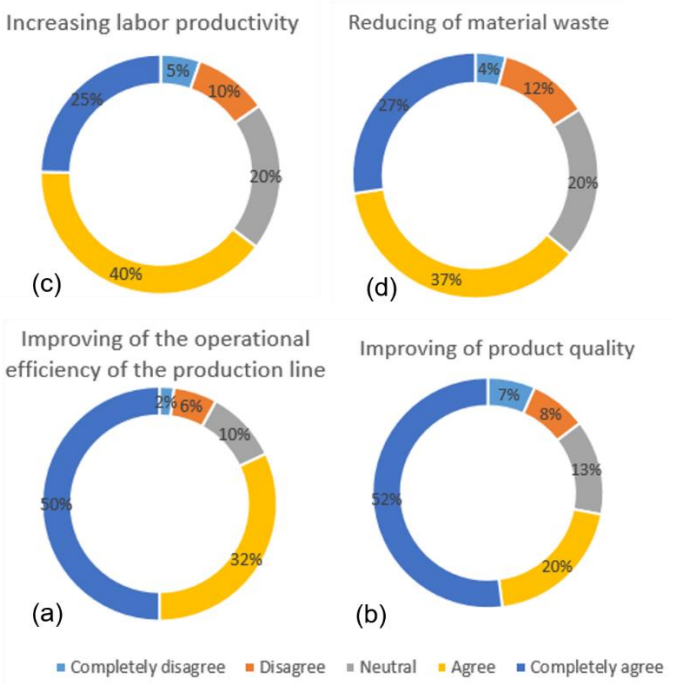

Figure 3. Benefit factors (including: Improving of efficiency of production line, improving of product quality, increasing of labor productivity and reducing of material waste) when implement smart factory model.

3.2 Challenges implementing of Smart factory

As per the survey data, about 93% of the enterprises that participated in the survey agreed or completely agreed with the view that challenges when implementing smart factory was lack of human resource as shown in Fig. 4(a), while only 6% of the respondents did not agree with this challenge. Factory staff frequently lacked a common vision for and understanding of smart factory implementation. In addition, factory personnel communicate using diverse language around the scope of the smart factory transformation and the need for capabilities development. Further complexities are introduced by attachment to the prior generation of

production technologies and the perceived threat to established competencies.

Also, 97% of surveyed respondents agreed or strongly agreed with the point that challenges when implementing smart factory was the deployment cost (87% of survey respondents completely agreed with this view) as shown in Fig. 4(b). In addition, in Fig. 4(c), 57% of survey respondents agreed or strongly agreed that challenges when implementing smart factory was the selection of technology solutions (27% of survey respondents fully agreed with this view). The highly complex nature of smart factory technologies and systems makes it is hard to gauge the potential benefits, creating an uncertain business case for implementation. Indeed, the systemic nature of smart factory implementation creates uncertainty about the particular adaptations that may be needed with regard to other technologies, processes, and workforce capabilities. Moreover, 82% of the surveyed respondents agreed or strongly agreed with the idea that challenges when implementing smart factory was identified risk ownership for cyberattacks in smart factories (57% of survey respondents fully agreed with this view) as shown in Fig. 4(d).

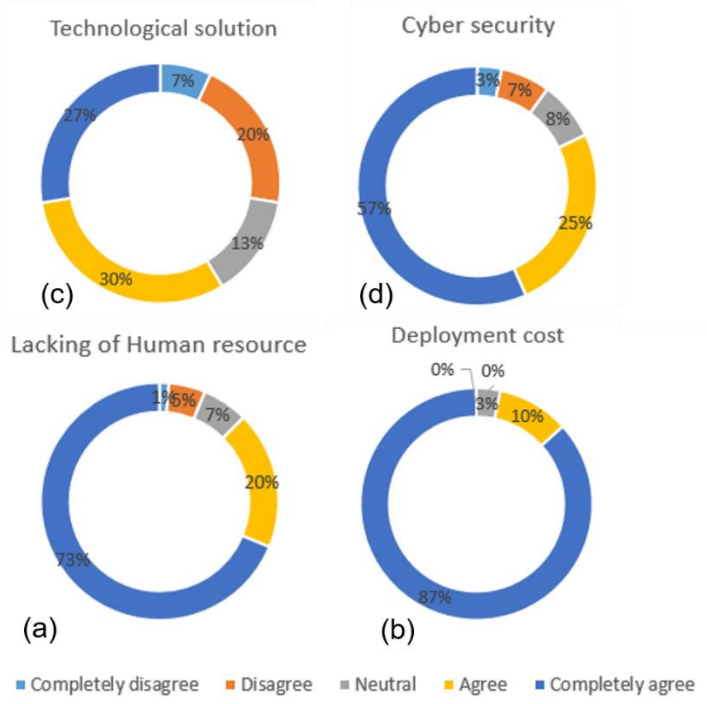

Figure 4. Challenge factors (including: Lack of Human resource, Deployment cost, Technological solution and Cyber security) when implement smart factory model

4. Solutions for promote the development of smart factory in Vietnamese enterprises

From the above survey results, some solutions to develop of smart factory in enterprises are proposed as follows:

4.1 Development of Model Smart factory Ecosystem

In order to support enterprises to deploy smart factory, the formation and development of smart factory ecosystem is critical. The author proposes the smart factory ecosystem includes government, consulting organizations, training institutions, financial institutions, logistics units, foreign organizations (Fig. 5).

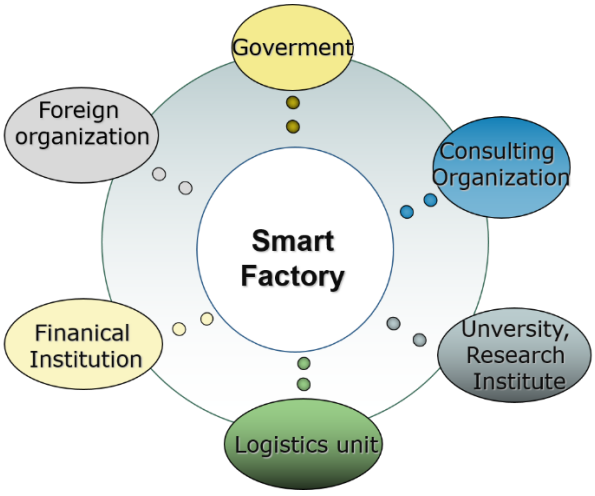

Figure 5. Model smart factory ecosystem include the components: Government, Consulting organization, Education units, Logistic units, Financial institution and Foreign organization

4.2 Improving the Quality of Human resource

Workers in the smart factory will have to learn more about machines. Instead of manually working hard, people will play a higher role. The reason is because the machine takes all the repetitive and heavy work. Therefore, as humans embrace to usher in smart factory, it has become imperative for nations as well as organizations to embark on education systems that are more focused on knowledge beyond what the world currently preach. This may require teaching creativity to children at an early age (Early Childhood Education) right up to university levels. Therefore, nations need to revolutionize their education systems that produce super humans capable of surviving in Smart Manufacturing. Hence, result in producing human capital that is needs for Smart factory competitiveness.

4.3 Financial policies to support for deploying smart factory

Given the significance of science and technology in business development, product quality enhancement, and competitive advantage enhancement, the Vietnamese government should concentrate on offering technological innovation support for business. With the purpose of implementing this policy, the Prime Minister's Decision No. 1342/QD-TTg, dated August 11, 2015, established the National Technology Innovation Fund (NATIF). The primary functions of the NATIF are to provide support to businesses, associations, and individuals engaged in innovative technology applications, commercializing the outcomes of scientific research and technological advancement to introduce novel products and services with a high technological content and high added value to the market. Furthermore, in order for enterprises to be able to finance themselves, more research and improved credit policies are required. Additionally, in order to support businesses in technological innovation more effectively, it is necessary to conduct additional research and enhance credit policies. This is because the government must have some orientations focused on improving the technology of enterprises, particularly in priority fields and industries.

4.4 Build in security.

Since many smart factory use cases are still in planning and early stages, now is the time to harmonize these projects with your cyber risk program. Design and include the appropriate security controls at the start of these

projects. Important controls to consider include: use of secure network segmentation models, deployment of passive monitoring solutions (to provide visibility of networked assets and activity while minimizing the risk of disruption), secure remote access, control of removable media, improved management of privileged access, and executing consistent data backup processes (especially for critical systems and configurations).

4.5 Design a specific smart factory model for Vietnamese businesses

Based on survey results and references according to ISA-95 standards [15], the smart factory model is designed to suit the characteristics of Vietnamese manufacturing enterprises with 4 layers of IT-OT system to ensure connectivity and interaction with two-way information as shown in Figure 6.

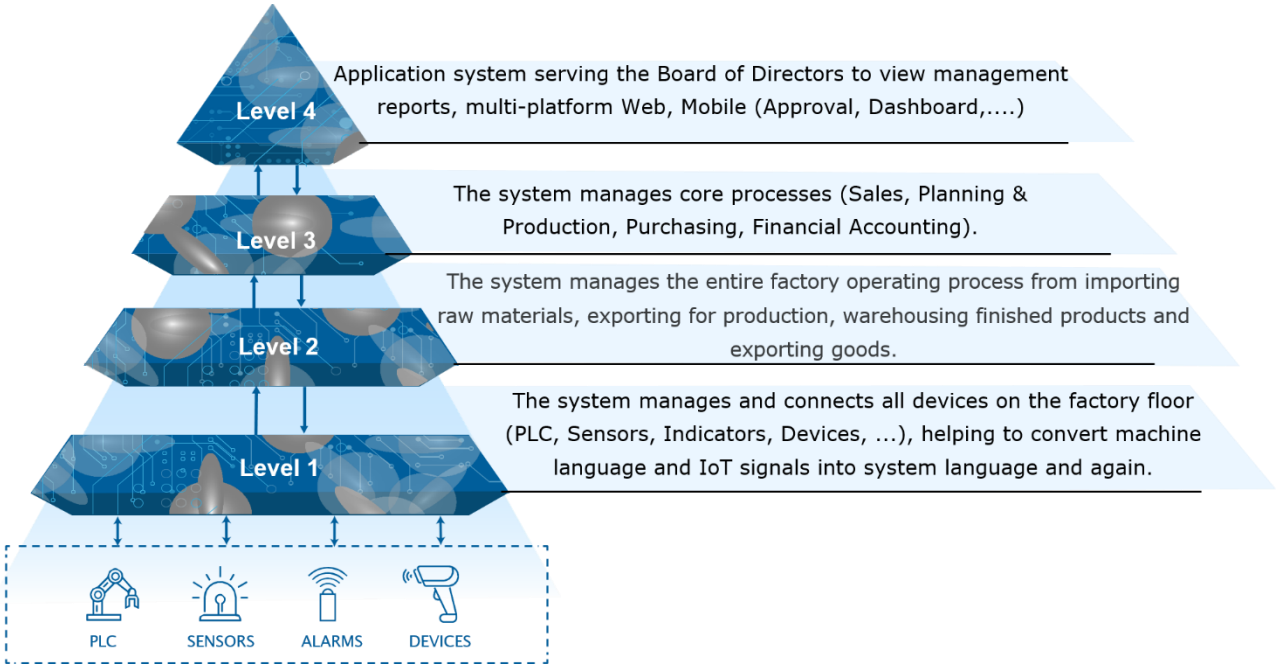

Figure 6. The proposed smart factory model is suitable for the specific characteristics of Vietnamese businesses

5. Conclusion

Under the impact of the 4.0 industrial revolution, the digital transformation platform has opened up a digital economy full of opportunities and challenges for industrial manufacturing enterprises. The achievements of the 4.0 technology revolution have promoted the development of the smart factory model. Thanks to the application of advanced digital technology platforms such as IoT technology, artificial intelligence and automation, smart factories promise to be a solution that brings a leap forward for the manufacturing industry and helps businesses grow. sustainability in the digital economy. Starting from that prospect and opportunity, the smart factory is the key to opening a new, successful direction for organizations and businesses in the digital transformation journey. With this trend, many factories have been implementing digital technology and smart application models in the production process. In this article, we conducted a survey of the benefits and challenges when applying the smart factory model in Vietnamese manufacturing enterprises. Survey results

show that most businesses are clearly aware of the advantages of applying the smart factory model as well as the current barriers when applying this model. The survey results serve as a basis for proposing a number of solutions to promote the application of smart factory models in Vietnam in the future.

Acknowledgment

This work was supported by Dong Nai Technology University Research Fund in 2024.

References

[1] Q.C, Nguyen, H.T. Huynh, T.S. Dao and H.D Kwon, "Application of Internet of Things Based Monitoring System for indoor Ganoderma Lucidum Cultivation," International journal of advanced smart convergence, Vol.12, No.2, pp.153-158, 2023.
DOI: https://doi.org/10.7236/IJASC.2023.12.2.153

[2] Q.C, Nguyen, Q.H. Nguyen and J.S Cha, "Study on Automatic Human Body Temperature Measurement System Based on Internet of Things," International journal of Internet, Broadcasting and Communication, Vol.6, No.2, pp.51-58, 2024.

[3] Q.C, Nguyen, Q.H. Nguyen and J.S Cha, "Design an Automatic System to Control and Monitor the Process of Straw Mushrooms Indoors Cultivation," International journal of Internet, Broadcasting and Communication, Vol.6, No.2, pp.59-67, 2024.

[4] M. Blackburn, J. Alexander, J.D. Legan and D. Klabjan, "Big Data and the Future of R&D management, Research-Technology Management", Vol.60, No. 5, pp. 43-51, 2017.

[5] Germany Trade and Invest, Smart factory, https://industrie4.0.gtai.de/INDUSTRIE40/Navigation/EN/Topics/Industrie-40/smart-factory.html, accessed August 18, 2017.

[6] Gartner, https://www.gartner.com/en/information-technology/glossary/smart-factory

[7] W. MacDougall, "Industrie 4.0: Smart Manufacturing for the Future (20750) ," Technical report, Germany Trade and Invest, Berlin , Reprint May, 2016.

[8] L. Jay, B. Behrad, and A.K. Hung, "A Cyber Physical Systems architecture for Industry 4.0—Based manufacturing systems," Manufacturing Letters 3, pp.18–23, 2015.

[9] T. Stock and S. Guenther, "Opportunities of sustainable manufacturing in Industry 4.0", Procedia CIRP 40, pp. 536–541, 2016.

[10] H.M. Hiep, "Smart manufacturing readiness in Vietnam: An assessment survey and policy implications," The VMOST Journal of Social Sciences and Humanities, Vol.64, no. 2, pp. 24-37, 2022.

[11] A. Kusiak, "Smart manufacturing", International Journal of Production Research, Vol. 56. No.2, pp.508-517, 2018.

[12] H. Kang, et al, "Smart manufacturing: Past research, present findings, and future directions", International Journal of Precision Engineering and Manufacturing-Green Technology, Vol.3, No.1, pp.111-128, 2016.

[13] BnK Solution, https://bnksolution.com/news/the-outstanding-benefits-of-smart-factories

[14] SAP, https://www.sap.com/sea/products/scm/what-is-a-smart-factory.html

[15] Enterprise-Control System Integration (ISA95), https://www.isa.org/standards-and-publications/isa-standards/find-isa-standards-by-topic