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Promoting Efficient Smart Factories through Analysis and Status of Corporate Infrastructure Configuration

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Abstract

The smart factory promotion project is a project that improves the entire management environment system, including the production process, using ICT technology. According to the 2019 Smart Factory Survey and Analysis Research Report of the Ministry of SMEs and Startups, small and medium-sized enterprises that introduced smart factories reported positive effects such as increased productivity, improved quality, and reduced costs on average. On the other hand, the survey results of companies that promoted the project despite positive results showed that there was room for improvement. This study dealt with the contents of the survey conducted on companies by the smart factory promotion agency in 2020 regarding the infrastructure configuration for promoting smart factories. We examined the meaningful contents implied by the data related to the infrastructure configuration. These meaningful survey results can lead to more efficient business promotion in the future when promoting smart factory projects.

Keywords: *Smart factory, ICT, Smart factory level, Infrastructure.*

1. Introduction

The global economy is in a very difficult situation due to the surge in raw material prices, high exchange rates, etc. due to COVID-19, the Ukrainian War, and the Israeli War. This situation is also having a great impact on the domestic economy. Small and medium-sized businesses and individual service providers are facing more and more difficulties due to high prices and high exchange rates. This difficult economic environment is especially affecting relatively poor small and medium-sized businesses that are experiencing financial difficulties. To overcome this economically poor environment, many companies are participating in and promoting smart factory projects. The smart factory project is a project that improves the entire management environment system, including the production process, using ICT technology. The government has been supporting some of the necessary funds for companies promoting this project. In Korea, it has been continuously implemented since 2014. The organization that supports the smart factory project at the national level is the Smart Factory Promotion Agency. The meaning of a smart factory in the Smart Factory Promotion

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Agency is an intelligent factory that integrates all production processes from product planning to sales with ICT (information and communication technology) [1]. In these smart factories, each company is producing customized products for customers at the lowest cost and time. According to an issue report published by the Overseas Economic Research Institute of the Export-Import Bank of Korea, a smart factory is defined as a next-generation advanced factory that realizes productivity improvement, energy saving, and customized production by integrating factory operation and value chain processes through informatization, intelligence, and connectivity of the factory [2].

In Korea, the smart factory promotion project has produced positive results in some companies even in difficult environments such as the COVID-19 situation. In particular, it has been reported that industries related to COVID-19 (masks, diagnostic reagents, etc.) have made great strides in increasing productivity and reducing costs through the transition to a smart manufacturing production system [5,6]. According to the 2019 Smart Factory Survey Analysis Research Report of the Ministry of SMEs and Startups, SMEs that introduced smart factories reported positive effects such as increased productivity, improved quality, and reduced costs on average. Despite these positive results, the survey results of companies that promoted the project showed that there was a lot of room for improvement [7].

In this study, we dealt with the contents related to the infrastructure configuration for promoting smart factories among the various survey contents conducted by the smart factory promotion agency on companies in 2020. We examined the meaningful contents and meanings implied in the related data. These meaningful survey results will be able to lead to more efficient business promotion in the future when promoting smart factory projects. In addition, if the various special features revealed in the survey results are reflected in the business promotion process, it is expected that the satisfaction of companies regarding the smart factory promotion project will also improve. As for the research contents, we first looked at the current status of smart factories in Chapter 2. Chapter 3 covers the current status and analysis of infrastructure for promoting smart factories. Finally, conclusions are presented.

2. Current status of smart factories

The smart factory promotion project in Korea is being implemented by the Smart Factory Promotion Team. The number of companies participating in the smart factory promotion project has been continuously increasing. In particular, the number of participating companies showed a sharp increase in 2019 and 2020. Many companies participated in 2020, even though it was the year when COVID-19 occurred. According to a survey by a related organization, 25,039 companies participated by 2021. The fact that many companies participated in the project during an economically difficult time means that there is a need to promote this project. The number of companies participating in the project by year from 2014 to 2020 is as shown in Table 1 below.

Table 1. Status of participating smart factories by year

year	2014	2015	2016	2017	2018	2019	2020	total
participating companies	227	963	1560	2203	2900	4757	7139	19799

(Source: Ministry of SMEs and Startups press release, Ministry of SMEs and Startups achieves 20,000 units of intelligent factories, 2021)

Currently, the smart factory promotion is divided into five stages from the ICT non-application stage to the advanced stage, as shown in Table 2. It is common and desirable to promote it in stages in most cases. However, it is not necessary to proceed through 5 stages. Depending on the company's situation, the intermediate stage 1 can be promoted without the first stage, the basic process. Of course, there is no objective data yet on whether this result is desirable.

Table 2. Smart factory promotion stages (smart factory level)

Division	On-site automation	Factory operation	Enterprise resource management	Product development	Supply chain management
High	IoT/IoS-based CPS				Business on the Internet CPS network collaboration
	IoT/IoS-based	IoT/IoS (modular)-based big data-based diagnosis and operation			
Medium 2	Facility Control Automation	Facility Control Automation	Real-time Process Control	Simulation and Batch Process Automation	Multi-product Development Collaboration
Medium 1	Automatic collection of facility data	Automatic collection of facility data	Real-time decision-making	Automation & collaboration of technical information creation	Multi-variety production collaboration
Basic	Performance Summary Automation	Performance Summary Automation	Process Logistics Management (POP)	Technology/Delivery Management via Server	Dependence on a Single Parent Company
ICT not applied	Manual	Manual	Manual	Manual	Telephone & email collaboration

3. Status and analysis of infrastructure configuration for smart factory promotion

The basic data for this study is the survey conducted by related organizations in 2020. Chapter 3 covers the current status of infrastructure configuration for smart factory promotion by each company by sales size.

3.1 Possession of promotion strategy and promotion system

When promoting smart factories, the promotion strategy and promotion system within a company are very important factors for the successful construction of a smart factory. The specific items for the investigation of promotion strategy and promotion system by sales size consist of 6 items. The results of the investigation are as shown in Table 3 below. 4,000 companies participated in this investigation. Details of the items described in Table 3 are as follows. A: Number of responding companies, B: Not in possession of smart strategy and promotion system (%), C: Planning to adopt official smart strategy and promotion system (%), D: Developing smart strategy and promotion system strategy (%), E: Promoting official smart strategy in at least one field (%), F: Promoting official smart strategy in two or more fields (%), G: Official promotion of smart strategy, continuous review and supplementation reflecting the situation (%).

Table 3. Possession of smart factory promotion strategy and promotion system unit: Won (Korea)

Sales	500 million - 2 billion	2 billion - 5 billion	5 billion - 8 billion	8 billion - 12 billion	12 billion - 20 billion	20 billion - 50 billion	50 billion - 150 billion
A	692	719	452	428	493	707	509
B	85.3	79.6	77.2	70.8	72.4	62.5	47.7
C	8.2	10.6	12.8	18.9	16.4	21.2	28.3
D	2.2	3.6	4.4	3.5	3.7	4.8	10.2
E	2.0	2.9	2.9	3.0	3.4	6.1	6.3
F	0.3	1.1	0.4	0.7	1.2	1.3	2.6
G	2.0	2.2	2.2	3.0	2.8	4.1	4.9

The significant contents shown in this section are as follows. First, the results for items that do not have a smart strategy and promotion system were higher in companies with smaller sales volumes overall, except for companies with sales between 12 billion and 20 billion won. The results of the survey on the second item, planning to adopt an official smart strategy and promotion system, were higher in the order of large companies in general, except for the group of companies with sales of 12 billion to 20 billion. The results of the survey on the third item, developing a smart strategy and promotion system strategy, were also higher in the order of large companies in general. However, the 5 billion to 8 billion range was an exception. The results of the survey on the remaining three items were higher as the sales increased. The following conclusions can be drawn from the data shown in these survey results. First, it can be interpreted that the more sales increase, the more active the response is in the process of promoting smart factories. The results of this survey are very desirable for promoting smart factories. They can also be considered as content that can guarantee the successful promotion of the project. Second, the survey results showed that most companies do not have a smart strategy and promotion system or are planning to adopt an official smart strategy and promotion system. Therefore, a detailed strategy to induce these companies to actually promote smart factories seems necessary. For example, it is to discover companies that are representative success stories with similar sales volume. The contents of the companies' success stories can act as a catalyst to promote the introduction of smart factories to these companies through online or offline promotional activities.

3.2 The most necessary part when promoting the introduction of smart factories

The survey on the most necessary support areas when companies introduce smart factories was composed of five items as shown in Table 4 below: (a) factory operation system, (b) manufacturing automation (enterprise resource management), (c) process simulation (supply chain management), (d) ultra-precision mold, (e) others. In addition, 2,005 companies participated in this survey. Details of the items described in Table 4 are as follows. A: Number of responding companies, B: Factory operation system (%), C: Manufacturing automation (enterprise resource management) (%), D: Process simulation (supply chain management) (%), E: Ultra-precision mold (product design and process development) (%), F: Other.

Table 4. The most necessary part among the government's support areas

Sales	A	B	C	D	E	F
500 million - 2 billion	324	61.4	35.5	1.9	0.9	0.3
2 billion - 5 billion	329	56.2	41.6	0.9	1.2	0

5 billion - 8 billion	219	51.1	47.0	0.9	0.9	0
8 billion - 12 billion	196	49.0	48.5	2.0	0.5	0
12 billion - 20 billion	235	48.1	49.4	2.1	0.4	0
20 billion - 50 billion	412	53.9	44.2	1.5	0.5	0
50 billion - 150 billion	290	45.2	51.0	1.4	2.4	0

The significant findings from this survey are that the smart factory sectors that all respondent classes demand are factory operation systems or manufacturing automation. Other sectors are shown to be very minimal. Therefore, there is a need to continue to provide intensive support for factory operation systems and manufacturing automation.

3.3 Government suggestions for activating smart factories

The results of the survey on companies' suggestions for the government to activate smart factories are shown in Table 5 below. The survey items consist of 8 items – financial support, education support, promotion reinforcement, information provision, customized support for companies, human resources support, technical support, and none. 2,005 companies participated in this survey. Details of the items described in Table 5 are as follows. A: Number of responding companies, B: Financial support (%), C: Education support (%), D: Promotion enhancement (%), E: Information provision (%), F: Customized support for companies (%), G: Human resources support (%), H: Technical support (%), I: None (%).

Table 5. Government suggestions for activating smart factories (multiple responses)

Sales	500 million - 2 billion	2 billion - 5 billion	5 billion - 8 billion	8 billion - 12 billion	12 billion - 20 billion	20 billion - 50 billion	50 billion - 150 billion
A	324	329	219	196	235	412	290
B	0	1.2	0.5	1.5	0	0.5	0.3
C	0	0	0	0	0	0.2	1.0
D	0	0.3	0.5	0	0	0.2	0.3
E	0	0	0	0	0	0.5	0
F	0	0	0	0	0	0.7	0
G	0.3	0.3	0	0	0.4	0.5	0
H	0	0.3	0	0	0	0	0
I	99.7	97.9	99.1	98.5	99.6	97.3	98.3

Overall, it is difficult to derive meaningful results from the response results for all business groups. However, the fact that business groups with very small sales volumes were found to need financial and human resources support can be considered a reality that can occur because they are small business groups. Looking at the entire business group, financial support was the top priority. In addition, according to the Export-Import Bank of Korea report, the biggest difficulties in the process of promoting the introduction of smart factories were the burden of investment funds (46.4%) and the burden of maintenance (31.4%). This shows that the most important suggestions are related to financial support. Therefore, various measures seem necessary, including financial support during the introduction process and financial support during the maintenance phase.

Based on the research results and analysis of the three items described above, we have briefly presented the direction of advancement according to the main contents in Table 6.

Table 6. Direction of advancement

Main Contents	Promotion Direction
• The results of the items that do not have a smart strategy and promotion system are generally higher the smaller the company size. • The survey results on plans to adopt smart strategy and promotion system were generally high in companies with large sales volume. • Most companies do not have smartization strategies and promotion systems or are planning to adopt official smartization strategies and promotion systems.	• A differentiated strategy seems necessary to encourage these companies to actually promote smart factories. • This is to discover companies that are representative success stories with similar sales volume. By sharing the contents of companies' success stories online or offline, it can serve as a catalyst to promote the introduction of smart factories.
• The smart factory field that all response levels requested was factory operation systems or manufacturing automation.	• Need for continued intensive support for factory operation systems and manufacturing automation
• Small-scale companies are surveyed as needing financial and human resources support	• Various forms of financial support seem necessary during the construction and maintenance phase

4. Conclusion

Smart factories are being implemented in various forms worldwide for the purpose of improving corporate productivity and management. The government has also been providing various support to companies through smart factory promotion projects. According to various press releases, companies are improving management such as improving productivity and reducing costs through smart factory support projects. In this study, we covered the contents related to infrastructure configuration for smart factory promotion among the various survey results conducted by smart factory promotion organizations in 2020. We examined the meaningful contents and meanings implied in the data related to infrastructure configuration. These meaningful survey results will be able to lead to more efficient business promotion in the future when promoting smart factory projects. In addition, it seems that the participation rate of companies in the project can be increased as the contents reflect the reality of companies. In addition, if the various special features revealed in the survey results are reflected in the business promotion process, it is expected that the satisfaction of companies with smart factory promotion projects will also be greatly improved.

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