

## Operational Problem Analysis and Improvement Plan in the Smart Factory Promotion Process

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### Abstract

Uncertainty is increasing around the world due to COVID-19 and Ukraine crisis. In this situation, each company is making countless efforts to survive. In Korea, smart factory projects targeting small and medium-sized businesses with difficulties have been continuously promoted. As for the smart factory business that has been promoted so far, the base expansion of the smart factory is also steadily increasing as the number of companies carrying out the project is increasing. It was also found that it contributed to productivity improvement and quality improvement. Despite these positive aspects, difficulties and operational problems are also appearing in the process of promoting smart factories. In this study, we investigated and analyzed operational problems and difficulties in the process of promoting smart factories. In addition, improvement plans for problems were presented according to the contents of this analysis, and improvement plans were presented by classifying them into introduction and supply companies, considering that the smart factory business is formed in the form of a consortium between introduction and supply companies.

**Keywords:** Smart Factory, Implementation Process, Internet of Things, Information and Communication Technology, Intelligence

### 1. Introduction

Due to the recent deterioration of the global economic environment, Korea's economic environment is also experiencing difficulties. These economic difficulties appear to have a relatively large impact, especially on small and medium-sized enterprises (SMEs). In order to overcome this poor environment, many companies are participating in the smart factory business and promoting it. The main purpose of the smart factory business is to improve the management environment system including production using information and communication (ICT) technology. The meaning of smart factory can appear in various contents. In the Smart Factory Promotion Team, which supports the smart factory business nationally, the smart factory is a person-centered system that produces customized products at minimum cost and time by integrating all production

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processes from product planning to sales with ICT technology. It is described as an advanced intelligent factory [1]. The countries leading smart factories worldwide are the United States and Germany [2, 3, 4, 5, 6, 7]. These countries have established the concept of smart factories early on and established various cooperative relationships between the government and the private sector, and are implementing various attempts for the success of innovative smart factories. So far, these countries have shown clear differences in the direction of promoting smart factories. Table 1 compares the characteristics of smart factory promotion.

**Table 1. Smart factory promotion characteristics between the US and Germany**

	Driving entity	Characteristics
United State	private led	<ul style="list-style-type: none"> <li>• Market-based standardization based on IIC</li> <li>• Market expansion and strengthening of related technology capabilities through platform</li> <li>• Expansion of use cases through collaboration between companies</li> <li>• Combination of AI and AR/MR</li> </ul>
German	government led	<ul style="list-style-type: none"> <li>• Diffusion to continuous process</li> <li>• Strengthen smart services</li> <li>• Strengthen international technical cooperation</li> </ul>

In this study, the desirable aspects of the smart factory promotion process have been described, and difficulties in application and operational problems in the field of companies that have introduced smart factories have been investigated and analyzed. Based on this, improvement plans for the problems were described.

## 2. Progress of Domestic Smart Factory Business

The domestic smart factory project has been continuously promoted since the early 2010s under the supervision of the Small and Medium Business Administration at the time, and has been ongoing for the purpose of innovating the manufacturing process. It has been investigated that various positive effects - productivity increase, cost reduction, etc. - have appeared as a result of this continuous business [8]. According to the smart factory research and analysis report conducted by the Ministry of SMEs and Startups in 2019, small and medium-sized enterprises (SMEs) that have introduced smart factories have improved by about 30% in terms of productivity on average. Also, in terms of quality improvement, 43.5% was found to have improved. This survey was analyzed for 5,003 companies that introduced smart factories from 2014 to 2017 [8].

In addition, in 2021, the Ministry of SMEs and Startups announced performance data on the smart factory business in 2020, and according to this data, it was announced that it was successful in three aspects [9]. First, it is the expansion of the smart factory base. Smart factories were supplied to 7,139 companies, exceeding the target of 5,600. In addition, the upgrading rate also increased by 17.9% compared to 2019. The second is the expansion of private initiatives such as win-win partnerships between large and small businesses. Among the 7,139 smart factories, 2,409 privately-centered supplies, such as large-small and medium-sized win-win types and smart factory level checks, are an increase compared to 2019 (1,937). Lastly, as the demand for quarantine goods surged due to the spread of COVID-19, the private and public sectors cooperated to quickly support large-scale, small- and medium-sized smart factories. In addition, it presented a successful model for K-quarantine, such as mass production system conversion.

### 3. Problems and Improvement Plans

#### 3.1 Operational Problems

In Chapter 3, we looked at operational problems and difficulties in the process of promoting smart factories. Data on these operational problems and difficulties were based on survey data from related institutions [10]. The contents described in Table 2 are the results of a survey on the difficulties in the process of utilization after building a smart factory among the contents of the SMEs informatization level survey conducted by the Small and Medium Business Technology Information Promotion Agency in 2017. Eighty-eight manufacturing companies participated in the survey. The main content of the survey data is that the expected business improvement effect is not large, and defects or instability of the established system appear. In addition, difficulties in improvement and maintenance required in the process of application to the construction system, difficulties in application because the work process does not match well with the technology of the construction system, lack of necessary training and manpower for operation and management of the construction system, staff It includes passive participation due to lack of awareness among them.

**Table 2. Major problems in smart factory operation in 2017**

Contents	Ratio (%)
• Difficulties in improvement and maintenance required in the application process	45.4
• Complex and many related tasks	39.7
• Lack of expected work improvement effect	35.2
• Lack of operational and management manpower	31.8
• Defects and instability of the build system	28.4
• It is difficult to apply because it does not fit with the existing business system	21.6
• Passive participation due to members' lack of awareness	13.6

For the contents described in Table 2, the detailed data investigated based on the number of employees are shown in Table 3. As for the main characteristics shown in Table 3, items D, H, C, and B were generally high in company groups with a small number of employees, whereas item F was generally high in company groups with many employees. First, looking at the difficulty of improvement and maintenance required during the application process, which is section D, the ratio is generally high in companies with a small number of employees. This is a situation in which a company with a small workforce lacks professional management personnel to manage the business. In this situation, additional work such as improvement of work process required in the application process can be a burden to the company, and it is difficult to maintain the system. In this situation, it can be seen that the characteristic of the item related to the shortage of operating and management manpower, which is H, is also high in the company group with a small number of employees. Item C, the defect and instability of the established system, is also generally high in companies with a small number of employees. In the item F, which is that there are many and complicated related tasks such as necessary training and work improvement, companies with a large number of employees appear high.

**Table 3. Major problems in smart factory operation according to company size (number of employees)**

number of employees	A	B	C	D	E	F	G	H	I	J
5-9	4	50.0	25.0	50.0	0.0	25.0	25.0	50.0	0.0	25.0
10-19	14	28.6	35.7	42.9	14.3	14.3	0.0	42.9	0.0	14.3

20-49	22	41.0	31.9	49.9	22.6	45.4	9.1	22.8	0.0	13.7
50-99	22	22.7	22.7	31.8	31.8	40.9	36.4	36.4	0.0	9.1
100-299	26	42.3	26.9	53.8	19.2	50.0	3.8	26.9	3.8	11.5

(A: Number of responding companies (number), B: Absence of expected business improvement effect (%), C: Defects and instability of the established system (%), D: Difficulty in improvement and maintenance required during the application process (%), E: It is difficult to apply because it does not fit well with the existing business system (%), F: There are many and complicated tasks such as necessary training and business improvement (%), G: Passive participation due to lack of awareness of (managers-employees) (%), H: Lack of operational and management personnel (%), I: Others (%), J: None (%))

Let's look at another survey related to smart factory promotion. The following is the result of a survey on the difficulties (multiple responses) in the process of promoting a smart factory among the contents of the SMEs informatization level survey conducted in 2017 [10]. These contents are related to the difficulties faced by the adopting company in the process of promoting the smart factory business. In the results of the survey, the lack of smart factory information, the preparation of initial investment funds, the uncertainty of the investment effect, and the difficulty of calculating the accurate input budget are the main difficulties, which can be seen as concerns about the input budget and recovery possibility. These concerns seem to require specific solutions, such as delivering related information through various methods of briefings prior to business promotion in the process of promoting smart factories.

The main characteristics shown in Table 4 are as follows. First, items related to the lack of information related to smart factories are generally high in companies with a small number of employees. It can be seen as a phenomenon that occurs in an environment where information related to smart factories is not easily accessible due to the small size of the company. Second, the difficulty in calculating an accurate input budget and the initial investment fund raising also show a high overall ratio in the small business group. Since this is a small company, it can be said that it is the result of anxiety about the possibility of recovering the initial investment. Lastly, the lack of interest in the active use of the introduced system can be seen as the majority of companies that have not yet introduced the system as a smart factory business.

**Table 4. Difficulties in the process of promoting (introducing) smart factories according to company size (number of employees) (multiple responses)**

2017 Survey Criteria	Number of people (number of employees)					
	5-9	10-19	20-49	50-99	100-299	Total or average
Number of responding companies	69	79	94	59	56	356
Lack of smart factory related information (%)	65.2	53.2	58.5	61.0	47.7	57.4
Smart factory introduction consulting/absence of consultants (%)	18.8	22.8	23.4	23.7	10.8	20.5
Difficulty in calculating accurate input budget (%)	44.9	36.7	33.0	35.6	27.0	35.6
Raising initial investment funds (%)	56.5	56.9	53.2	44.1	37.8	50.8
Uncertain return on investment (%)	39.1	24.1	39.3	37.3	46.8	36.6
Problems securing promotion/operating personnel (%)	26.1	25.3	16.0	30.5	22.5	23.4
Difficulty in building customized system for company manufacturing characteristics (%)	13.0	12.7	18.0	10.2	23.4	15.4
Upgrade and maintenance cost (%)	8.7	13.9	12.7	10.2	18.0	12.6

Lack of interest in actively utilizing the introduced system (%)	0.0	3.8	6.4	10.2	15.3	6.6
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### 3.2 Improvement Plan

The smart factory support project, which has been implemented by the Ministry of SMEs and Startups so far, has been reported to have generally positive effects through various investigations. On the other hand, if you look at some of the survey contents, difficulties and operational problems that introducing companies are facing in the course of business promotion are revealed. In terms of these difficulties and operational problems, a more efficient smart factory project can be promoted through the improvement plan, and the possible improvement measures for the problems are described.

The smart factory project is a project made by a consortium between introducing and supplying companies. Therefore, the problems were divided into introducing and supplying companies and examined. First, from the perspective of introducing companies, many small companies are included in the companies that apply for and promote smart factory projects. These companies are in a situation where they cannot professionally manage the work of each part due to a lack of management personnel. Therefore, these companies show problems such as lack of operation and management manpower, difficulties in improvement and maintenance required in the application process. Therefore, in order to improve these problems even a little, operation and management manpower is required before applying for a business, which is the pre-introduction stage of the smart factory system, and at the same time, the need for professional manpower for continuous system operation or stable operation through contracts with maintenance companies need to be recognized.

Next, looking at the problems from the supplier side, first, defects and instability of the construction system can be mentioned. The problem is highly likely to occur due to participation in the project despite the lack of performance capabilities of the supplier. Therefore, it seems necessary to have a system to verify this. Next, problems that are difficult to apply because they do not fit with the existing business system can also be seen as a result of the supplier's failure to apply the existing business process. It seems that these problems can also be improved by strengthening the business execution capabilities of suppliers and at the same time verifying through unit tests and integration tests between introduction and supplier companies. Table 5 shows the comprehensive improvement plans that can be implemented by introducing and supplying companies for operational problems.

**Table 5. Improvement plan for operational problems by introducing and supplying companies**

	Problem	Improvement plan
Key points for supplying company.	Defects and instability of the built system	<ul style="list-style-type: none"> <li>• It is necessary to evaluate the project execution capabilities of suppliers annually and reflect the results in the next year.</li> </ul>
	difficulty to apply because it does not fit well with the existing business system	<ul style="list-style-type: none"> <li>• This is a problem that arises when the business analysis of the supplier company does not match the established system, the supplier's business execution capability must be strengthened</li> <li>• Minimize problems by strengthening unit test and integration test verification steps between introduction and supplier companies</li> </ul>
Key points for introducing	Difficulty in necessary improvements and maintenance	<ul style="list-style-type: none"> <li>• Companies with small manpower lack professional management manpower to manage the work, so the need for manpower is improved to be notified before project execution</li> </ul>

company	Lack of operational and management personnel	<ul style="list-style-type: none"> <li>• It is necessary to publicize the need for manpower through various methods such as business briefings before project execution</li> </ul>
	Concerns primarily about input budget and payback potential	<ul style="list-style-type: none"> <li>• Investigate the average input budget, etc. by industry according to the execution function for the companies that have performed it, and provide the average amount as a guideline</li> </ul>
	Lack of information on smart factories	<ul style="list-style-type: none"> <li>• Deliver related information through briefing sessions in various ways prior to project promotion</li> </ul>

#### 4. Conclusion

The smart factory business is steadily being implemented even in difficult economic environments around the world. It is also essential for a sustainable business environment. Smart factory projects carried out so far have positive aspects, but also show various problems in the implementation process. In this study, we described trends in the US and Germany, which lead smart factories, and the situation in Korea, and analyzed operational problems and difficulties in the process of implementing smart factory projects in Korea. In addition, since the smart factory promotion project is a project that is carried out in the form of a consortium between introducing and supplying companies, these problems were analyzed by dividing them into introducing and supplying companies, and based on this, improvement plans between introducing and supplying companies were presented.

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