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# Design of Business Model for Smart Factory Solution Application

[1]Sangcheol Lee

[1]Chungnam Institute for Regional Program Evaluation,

277 cheonan-daero, Dongnam-gu,

Cheonan-si, Chungcheongnam-do, 31212, Korea.

leebiz@irpe.or.kr

## Abstract

As the era of smart industrial revolution and the age of aging, efforts to strengthen the competitiveness of manufacturing industry through ICT convergence are increasing. In particular, a smart factory is essential to improve productivity and secure manufacturing competitiveness due to structural reasons such as shortening working hours and low-cost labor. Therefore, in this paper, we have developed a performance evaluation system based on the introduction of smart factory solution and conducted research to design business model connected with it. To this end, we designed the technology and management-wide procedures that could occur due to the system connection at the smart factory that integrates the entire life cycle of manufacturing ecosystem such as product planning and design, manufacturing process, distribution and sales into IT. In this paper, we analyze policy and technology contents for introduction and activation of smart factory to design business model for smart factory solution application. Through this, we have designed a business model based on the research on the establishment of the performance system necessary for the smart factory activation policy, the development of the governance, and the sustainable smart factory policy. The application of the designed business model can increase the productivity of the company and enhance the competitiveness. Based on the business model designed in this paper, it is possible to remove the unreasonable elements of the production process and to grasp real-time information in real time. In addition, it has resulted in improvement of business performance ability through optimization of manufacturing process.

**Key Words**:Smart factory, business model, ICT convergence, Smart technology, Production system, Smart cooperation model.

# 1. Introduction

Humanity is in another revolution. The direction of the revolution and the ripple effect are coming to us so fast that we cannot expect it at all. Industrial structure, and the 'Fourth Industrial Revolution' that will change human life. In recent years, there are concerns about the growth potential and competitiveness of the industry due to the aging of the workforce, the decrease in the number of producible people, and the stagnation of on-site productivity. In addition, due to structural reasons such as shortening of working hours and lowered wage labor, problems arise in terms of productivity improvement and manufacturing competitiveness. The core of the fourth industrial revolution is manufacturing intelligence. Artificial Intelligence, Big Data, Internet of Things, etc., are combined with cutting-edge technology, and the plant itself is smart enough to take part of the decision-making process itself. In each production line of each process, various environmental conditions such as time and temperature, and thus the data such as change in production amount and yield are collected in real time. Simulation with this vast amount of data can help to develop new products and improve existing products or processes without having to build new factories or turn machinery[1,2].

As a result, developed countries that have led the global economy based on the manufacturing industry are in desperate need of efforts to integrate manufacturing and ICT in order to regain the manufacturing competitiveness that has recently moved to emerging markets such as China. The introduction of smart factories should start from the perspective of promoting the balanced development of large enterprises and SMEs. The entire supply chain must be upgraded to secure cost competitiveness. Companies need to find a model that can grow together voluntarily, and the government needs to introduce smart factories into industries that are relatively less advantaged. In the global market, the fourth wave of industrial revolution is widespread, and in order for SMEs to cope with it, we must actively work on building a smart factory[3].

The Smart Factory is a system that combines ICT with traditional manufacturing to enable the entire process of raw materials, production process, distribution and sales to be networked, and all production data and information to be shared and utilized in real time. In other words, it refers to a customized factory that optimizes the production system by integrating all the manufacturing processes into information and communication technology (ICT), enhancing productivity and energy efficiency, and reducing product defect rate. By integrating information and communication technology (ICT) into all processes from product planning and design through distribution and sales, we will lower manufacturing costs and flexibly respond to the consumer market. Ultimately, it aims to strengthen manufacturing competitiveness. Manufacturing powers are accelerating efforts to secure manufacturing competitiveness in the future society through manufacturing-ICT convergence in response to the weakening labor base such as aging and the smart industrial

revolution. The smart factory solution is effective when it combines the three parameters in figure 1. This is called sensor, actuator and control. The detection function is a function that is managed with meaningful information by detecting events related to production such as changes in production conditions, earnings, and inventory position change. The actuator function is a function that is performed by reflecting the actuator result on the production site. Finally, the control function is a function to perform decision making such as work instruction, execution, suspension based on the detected production status information[4,5].

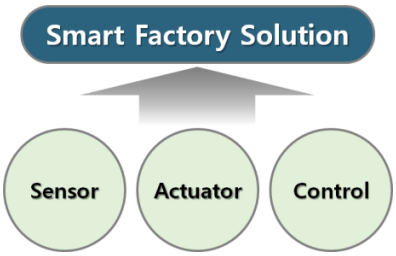


Figure 1: Three Parameters of Smart Factory Solution

There is a need to strengthen the expansion of smart factories with companies that have secured facility investment and companies that have willingness to invest in facilities, and it is necessary to continue to expand into smart factories through process standardization and automation. Therefore, in this paper, we have developed a performance evaluation system based on the introduction of smart factory solution and conducted research to design business model connected with it. To this end, we designed the technology and management-wide procedures that could occur due to the system connection at the smart factory that integrates the entire life cycle of manufacturing ecosystem such as product planning and design, manufacturing process, distribution and sales into IT. We analyze policy and technology contents for introduction and activation of smart factory to design business model for smart factory solution application. Through this, we have designed a business model based on the research on the establishment of the performance system necessary for the smart factory activation policy, the development of the governance, and the sustainable smart factory policy. The application of the designed business model can increase the productivity of the company and enhance the competitiveness. As a result, we have developed a financial performance evaluation system by introducing a smart factory to promote the voluntary diffusion of the private sector through the business model proposed in this paper, and have designed and applied the business model associated with it.

# 2. Smart Factory Solution

Smart Factory Solution means a factory that integrates product planning, design, manufacturing, process, distribution and sales into IT to produce customized products with minimum cost and time. As a result, it refers to a factory where the manufacturing process is automated and information based on IoT and CPS.

The entire value chain is aimed at a production system that integrates and integrates in real time like a factory. Through this, it is a solution that can improve productivity, energy saving, human-centered work environment, actively cope with new manufacturing environment such as personalized manufacturing and convergence. Smart factory solutions can be classified into product development stage, production stage, and purchasing/logistics stage. In the product development stage, product performance is simulated in virtual space before production to shorten the production period and develop customized products. In the production stage, real-time information exchange between equipment-material-management system improves the production of various products and energy and equipment efficiency in one factory. Finally, in the purchasing/logistics stage, real-time auto-ordering system tailored to the production situation dramatically reduces inventory costs and enables cooperation in all fields such as quality and logistics[6,7].

In such a smart factory solution, it is essential to design, develop and apply an authentication model and operating system that can objectively diagnose and evaluate the manufacturing smart level for the successful expansion of the smart factory and suggest a plan for building a customized smart factory. To this end, the KS standardized comprehensive evaluation system (inclusive of performance aspects including system construction, productivity, etc.) is provided in connection with private certification such as large corporations. In order to allow companies to introduce smart factories voluntarily and competitively "standard certification system", and based on the information and know-how gained during the development and application process of KPS (standard model, evaluation system, etc.) developed in the past, a framework for smart factory level diagnosis is proposed in figure 2. Smart plant solutions also include intelligent operating systems that utilize production information in figure 3.

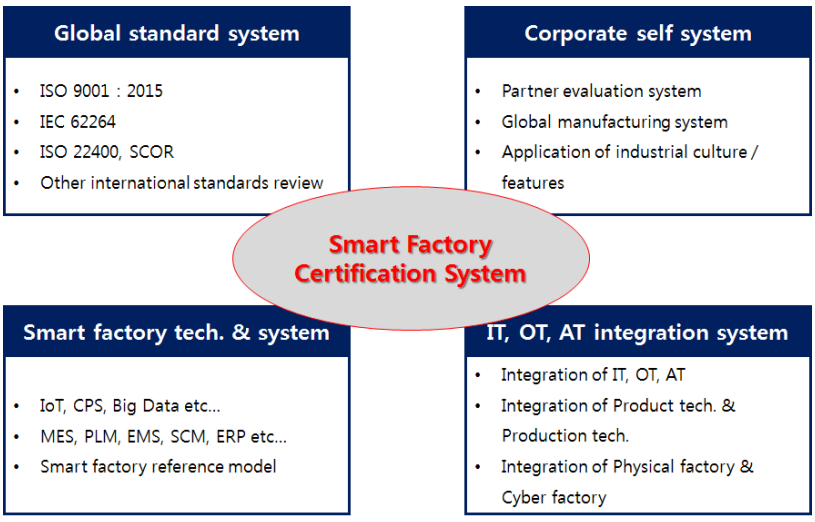


Figure 2: Smart Factory Certification System

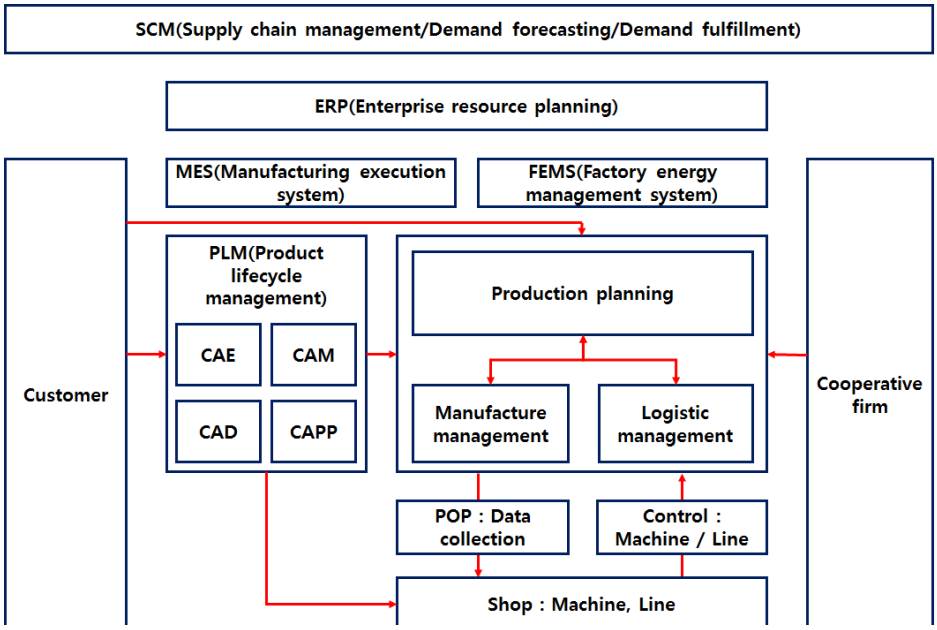


Figure 3: Smart Factory Operation System

The Smart Factory solution is based on the core technology of IIoT(Industrial IoT) and CPS(Cyber Physical System) technology, and it automates manufacturing, automation, real-time processing, intelligentization of equipment and the establishment of interworking system of variable production system through. In Germany, the impediments to the introduction of smart factories are focused on the diffusion of technological engineering research rather than on the creation of a market by customer needs rather than on the improvement of technology and quality of existing products, the creation of a substantial commercialization model, The efficiency of the internal process is higher than that of the efficiency, and the countermeasures are established and the action strategy is modified. In the United States, for manufacturing innovation, smart manufacturing structures and empirical research and projects, integrated processing for decision making and action in heterogeneous environments, context awareness data acquisition, modeling support, handling of uncertainties, synchronization, virtual security protocol control technology, and emphasizes the real-time nature of information systems[8,9].

In Korea, we are promoting the development of technologies for the construction of basic manufacturing information system, automatic acquisition of equipment information and control technology, development information sharing and optimization of manufacturing operation, and smart factory based on IOT. In addition, government agencies are carrying out various technical tasks related to smart factory upgrading and connectivity. In recent years, we are also promoting smart factory certification modeling and technology standardization roadmaps, interoperability centers and test beds, and the establishment of smart factory promotion teams.

At the heart of Smart Factory Implementation is the establishment of a platform for manufacturing and service optimization, linking external management resources within the plant based on manufacturing IoT technology. The technical composition of the platform is based on real-time collection of production data, analysis and application of production big data. The real-time collection technology of production data is performed by the collection device and middleware. In addition, Big Data analysis and application technologies involve process performance and quality variable verification, facility reliability analysis and forecasting, simulation and scheduling analysis. Integrated management such as production resource monitoring and analysis is performed by the platform OS and related modules[10,11]. There is no limit to the scope of technology convergence of smart factories, and Internet, cloud, big data, and mobile technology are optional in manufacturing operations management. Smart Factory's three core technology areas are applications, devices and platforms. In addition, engineering and manufacturing in an integrated environment, organic cooperation in the digital and real world, and screening of technical factors are important in figure 4.

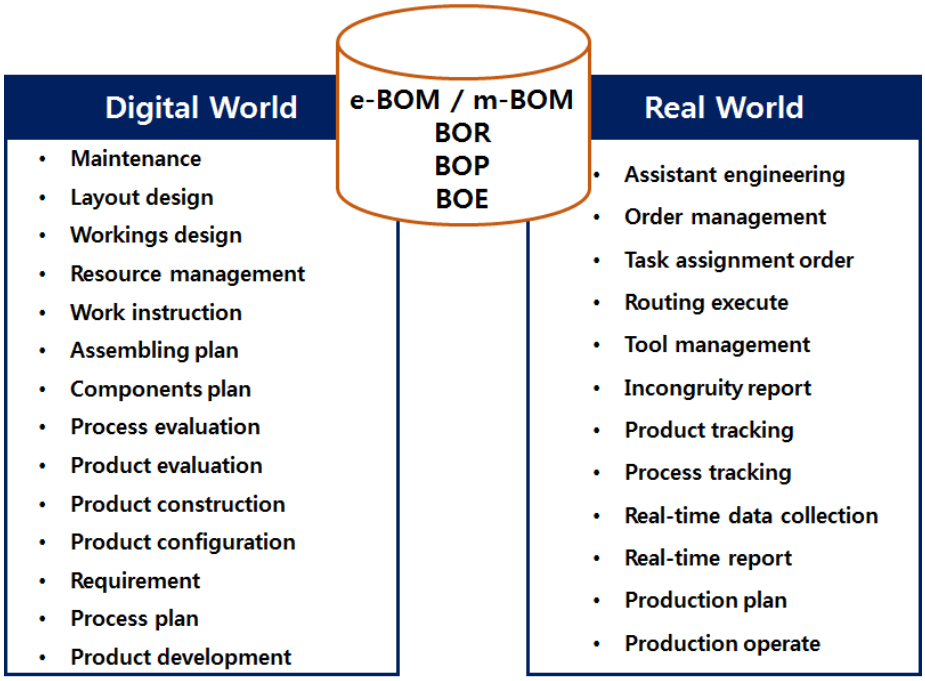


Figure 4: Technological Parameters of Digital & Real World

Smart Factory's technology needs include process optimization automation for custom-made flexible production, quality improvement based on real-time process data, integration of large-capacity manufacturing data, integration of smart factory application, manufacturing environment adaptive data collection and processing system, smart factory demonstration model, open industry-standard IIoT smart plant platforms for the manufacturing industry, and common industry standard areas for the connection of factory hardware, smart

factory deployment and diffusion applications. In recent years, the CPS has not been mentioned more than IIoT. However, automation and modernization of root companies and projects supporting and disseminating ICT convergence smart factories are mainly focused on MES, PLM and SCM linkage solutions. Is required.

# 3. Business Model Design

In this paper, we have developed a performance evaluation system based on the introduction of smart factory solution and conducted research to design business model connected with it. To this end, we designed the technology and management-wide procedures that could occur due to the system connection at the smart factory that integrates the entire life cycle of manufacturing ecosystem such as product planning and design, manufacturing process, distribution and sales into IT[12].

The most important part of the business model for applying smart plant solutions is the participation and cooperation of public and private enterprises. In other words, cost efficiency and efficient operation are possible through private efficiency and creativity through private financing, construction and operation integration. And, unlike maintenance that has been neglected since the establishment of the financial business, it is possible to strengthen maintenance through long-term reservation, and to utilize new technologies and specialized human resources. One of the major advantages of the business model centered on public-private partnerships is that it can provide budgetary savings, private efficiency and eligibility, and flexible and balanced risk sharing throughout the life of the project. In addition, the private-public cooperation business model can expand the financial investment capacity for social, welfare and education through SOC private investment. And, the ripple effects of the national economy are high, and the ripple effects that lead to the development of the capital market by applying various financial techniques are generated.

In order to apply the smart factory business model of reasonable public-private partnership, it is necessary to operate the system centered on the service consumer, not the public service provider, and efforts should be made to harmonize the publicity and profitability in figure 5. The government should actively participate in the strategic decision-making process of the project by strengthening public-private cooperation for business performance and risk management by matching government and private business goals. In addition, in order to prevent conflicts of interest between the government's role as an investor and its role as a procurement agency, a separate body from the procurement department within the Ministry of Finance should take charge of the government's contribution.

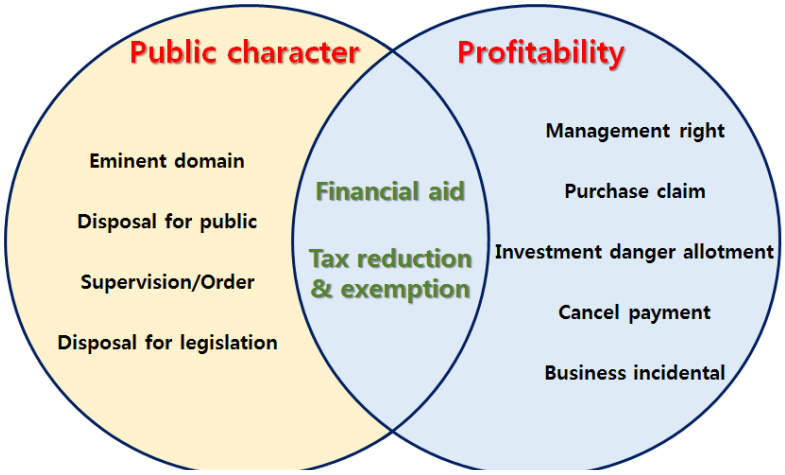


Figure 5: Cooperation Business Model Rule

The business model for SME smart plant solutions can be categorized in three ways. First, it is a public-private partnership investment model method. The public-private partnership investment model is a system in which investment-related entities certified by the government recoup the investment costs from the benefits generated after the institutional investment of SMEs. Second, it is an investment model led by public institutions. The public-funded investment model is a form of financial support that directly or indirectly supports the investment of SME facilities by the government. The application of this business model is transforming into a smart space with high productivity and energy efficiency through the construction of a smart infrastructure that integrates ICT into industrial complexes, which utilize government subsidies. Through this, SME plant solutions (MES, EMS, ERP, etc.) are supplied to manufacturing companies to optimize and streamline the production system, thereby improving productivity and reducing production costs. Third, it is an investment model led by private companies. The investment model led by private companies is funded through self - funding to modernize and smarten the production processes of large company - oriented partners.

The business model types of smart plant solutions can be analyzed according to the level, and value can be created depending on the type. Companies that meet the baseline level are built from traditional manufacturing methods to some automated processes and can collect simple manufacturing information. Through independent automation process of manufacturing company, it is easy to collect production data and collect facility data between production line functions, and it can be used as decision information based on this. Since the independent automation process of the manufacturing company is established and the cooperative production system between the first and the second companies is possible, it is possible to collect and process information centered on integrated operation and manufacturing companies in figure 6.

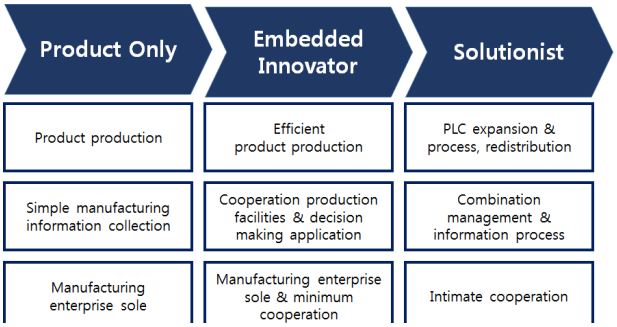


Figure 6: Step Type of Smart Factory Business Model

The smart factory business model is the key to creating original value by applying SME's production system as a smart system, and securing and maintaining smart factory facility resources. To this end, in the process of designing a business model, smart factoryization considering the level of SMEs, modeling linking with front-end industries connected with smart factories, creating value through smart factory construction and profit generation must be applied.

Therefore, production processes and products such as information sharing of production process, tracking management until finished product reaches customers, and so on should be provided to customers in the form of services. And for the entire product value chain, parts, materials, manufacturing, distribution, and customers should be linked logically through the network, and consumer needs should be reflected quickly. This means that customer needs are immediately reflected in product design and production, and adaptive responses of producers in the value chain of the product should be made quickly. In addition, it is necessary to provide an autonomous adaptive manufacturing environment that can enhance productivity, improve quality, and reduce costs by optimizing the manufacturing site in one place and adapting it to the actual site to adapt to the change of manufacturing site and dynamic change. Ultimately, we must not use hazardous substances in our products, recycle scarce metals, manage energy use efficiency, and provide human and environmentally friendly manufacturing environments such as dust, wastewater, noise management. In addition, the risk factors of the manufacturing environment should be detected and predicted in real time. And the integrated control system should provide a role to minimize the damage by avoiding the dangerous situation or early response.

# 4. Conclusion

The practical background for the implementation of smart factories is various from basic entry level of computerization to high level of autonomous control. As a background, it is possible to summarize the key issues of SMEs in SMEs' manufacturing industries, such as solutions to lack of technological development and investment capability, accurate knowledge of the technology

and confidence in the creation of performance. Therefore, in this paper, we have developed a performance evaluation system based on the introduction of smart factory solution and conducted research to design business model connected with it. To this end, we designed the technology and management-wide procedures that could occur due to the system connection at the smart factory that integrates the entire life cycle of manufacturing ecosystem such as product planning and design, manufacturing process, distribution and sales into IT.

As a result, the smart factory business model should be applied to the selection of the field diagnosis and solution provider, and the financing method, as concrete action plan for the customer self-promotion and the customized support strategy for each individual enterprise unit level. In addition, the technology system, operation optimization, design and quality improvement, and integrated SW integration should be operated in real-time acquisition and utilization of data in the manufacturing application layer. In addition, virtual and reality control production, big data analysis, and cloud service platform should be able to be practically constructed in the service platform layer. Finally, action plans and SW and HW development and verification for sensor and gateway interworking and data collection processing at device and network layers are important.

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