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MES Introduction and Activation Plan in Korean Small Manufacturers

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ABSTRACT
Manufacturing-oriented small companies have difficulty performing tasks such as production planning, process management, material management, and quality control suitable for small quantity production of various products to respond to diverse customer demands and changing market environments due to a lack of manpower and facilities. To solve these problems, the government is actively promoting smart factory support projects, and many small companies are participating in this project, and are building and operating MES (Manufacturing Execution System). However, most small companies are unable to build a system that suits the characteristics of the company. In other words, the introduced system is a general-purpose platform, and MES is not being utilized properly due to the absence of IT experts, the negative perception by existing personnel, and the CEO's neglect. Accordingly, in this study, we presented the causes of MES construction failure and improvement cases of company O., a small manufacturing company located in Daejeon city, where Root Industries is the main axis. That is, major problems in the introduction and operation of existing MES were identified, and improvements derived from the perspective of production workers were applied to the field. As a result, quantitatively, an improvement of 15% to 57% was achieved in terms of productivity, quality, cost, and delivery date, and qualitatively, the workload of both managers and production workers was reduced and work could be handled more easily. These research results can be used as a practical example for the successful construction and operation of MES in Korean small manufacturers producing a large variety of products. In the future, research will be needed to successfully develop MES from the basic level to the upper level.

KEYWORDS

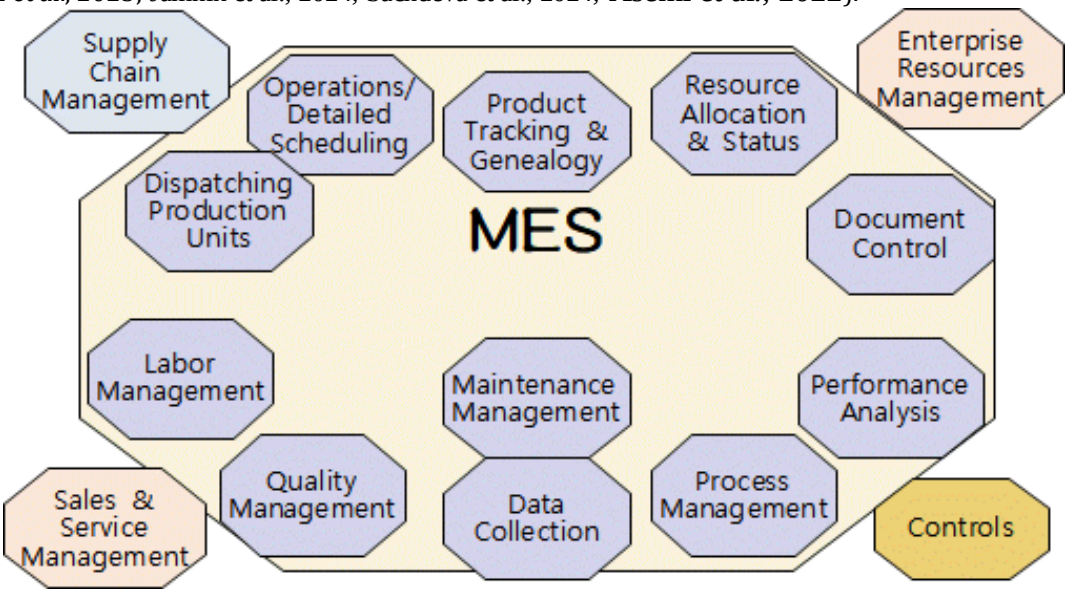
MES (Manufacturing Execution System), Daejeon city, Smart factory, Korean small manufacturers, Root Industries

1. INTRODUCTION

Small businesses centered on manufacturing are unable to properly perform tasks such as production planning, process management, and material management suitable for small-scale production of various products due to a lack of manpower and equipment, which reduces production efficiency and makes product maintenance difficult. Therefore, small manufacturers need the introduction of MES that automates and efficiently manages the production process from establishing production plans to real-time monitoring of product production sites and product shipment. The government is actively promoting smart factory support projects, and many small companies are participating in this project to build and operate MES (Manufacturing Execution System). However, most small companies are unable to build a system that suits the characteristics of the company. In other words, the introduced system is a general-purpose platform, and MES is not being utilized properly due to the absence of IT experts, the negative perception by existing personnel, and the CEO's neglect. MES (Manufacturing Execution System) is a system that manages all production activities from product ordering to finished product quality inspection as the basic stage of a smart factory. We collect various information from the production site in real time, including production

performance, worker activities, facility operation, and product quality information. It can be defined as an integrated production management system that provides a high-quality, profitability-oriented production system by managing counting/analysis/monitoring and production processes (Jeong & Lim, 2021). In other words, it is a comprehensive and dynamic software system that monitors, tracks, documents, and controls the product manufacturing process from raw materials to finished products, including real-time data utilization, operational/detailed scheduling, and real-time data utilization. As shown in <Figure 1>, resource management, schedule management, document management, and data management. Also, it has 11 core functions, including collection and acquisition, labor management, quality management, process management, maintenance management, product tracking history management, and performance analysis management. In other words, MES, which provides a functional link between enterprise resource planning (ERP) and process control systems, provides decision makers with the data they need to increase shop floor efficiency and optimize production. At the production site, it is a system that can increase production efficiency and reduce costs by managing the execution status of production plans in real time to respond to increasing customer requirements.

However, most small companies are unable to build a system that suits the characteristics of the company. In other words, the introduced system is a general-purpose platform, and MES is not being utilized properly due to the absence of IT experts, the negative perception by existing personnel, and the CEO's neglect. Accordingly, in this study, we intend to analyze the causes of MES construction failure and improvement cases of Company O, a small manufacturing company located in Daejeon, where the root industry is the main axis, in order to derive a plan to improve the operation of the existing MES. In the case of Company O, we have developed the basic MES stage to suit the company's production environment and have accumulated operational experience for 3 to 4 years. When it was first introduced, many aspects were unfamiliar, so I thought that as long as the system functions were met, it would be designed and built to suit the company. As time went by, it was not easy to manage materials, processes, and quality suitable for the small-scale production system of many products, so it was not used due to many difficulties and was used only as groupware for document management. This problem-solving process of Company O can be said to be very meaningful in that it will be of practical help in establishing MES introduction and operation strategies for related small and medium-sized manufacturers (Kumar et al., 2021; Semara et al., 2024; Tiwari et al., 2023; Jamnik et al., 2024; Sachdeva et al., 2024; Asemi et al., 2022).



<Figure 1> MES Functional Model

2. MATERIALS AND METHODS

2.1 Review of existing research

The main results of domestic research on MES targeting small and medium-sized manufacturing companies over the past 15 years from 2007 to the present are as follows.

Kim (2000) proposed four considerations for cell manufacturing and MES application as follows. First, you must first determine whether the unit production method for the product is appropriate and apply it. Second, it is essential to supplement the system to support so that the production process can be easily

completed. Third, we must first establish a program to foster multi-skilled talent who can independently perform multiple work processes. Fourth, workers' management mindset must be formed autonomously.

Joo (2008) stated that the reasons for MES construction failure are the difficulty of effective integration with ERP, etc., insufficient reflection of changes in the manufacturing environment and field requirements due to the absence of an optimization roadmap for manufacturing operations, and it was pointed out that there was a lack of preparation.

Lee (2008) said, "Unlike transaction systems, manufacturing execution systems can increase operational efficiency only when designed with a thorough analysis of field processes and consideration of final output, and minimize user interface in process and work design."

Lee et al. (2010) proposed "How to use sensors for general purpose machines and PLC for automatic machines" to demonstrate the real-time collection and efficiency of information available at the production site.

Shi et al. (2012) presented a methodology for introducing and applying MES based on SE (System Engineer) for the effective construction and distribution of MES tailored to the production environment characteristics of small and medium-sized enterprises centered on the manufacturing industry.

Jang and Lee (2013) developed a C/S-based MES (c-MES Basic) for small and medium-sized enterprises, and Lee et al. (2013) developed a c-MES (c-MES) optimized for production management of small electronic component manufacturers.

Lee et al. (2013) evaluated the level of production informatization of all companies in the form of MES construction targeting about 450 small and medium-sized manufacturing companies existing in Korea and presented an implementation methodology for this. In this study, the production informatization level was defined as a five-level model and was specified to reflect the concepts of the production informatization level model within the web operation platform.

Jeong et al. (2013) developed a customized introduction standard based on rule base for the introduction of MES in small and medium-sized manufacturing companies. By evaluating the MES level of the target company, we developed a diagnostic evaluation system that can understand the level of production informatization within the same industry and demonstrate its effectiveness.

Shiting (2014) pointed out the lack of infrastructure and appropriate MES software development within the company as one of the reasons for the failure of MES introduction and proposed a method to analyze the effect of introducing and applying MES through mergers and acquisitions.

Lee (2014) proposed a process model-based c-MES automatic feature recommendation framework and presented PMPM that can model internal/ external collaboration, part flow, etc. in the process analysis stage for the successful introduction of c-MES.

Shim and Won (2016) proposed a flexible MES method for LED manufacturing, where all line work is done manually and real-time information collection and control are difficult.

Park (2017) stated that smart factory systems, known as MES, ERP, and POP systems, are indispensable in the current 4th Industrial Revolution, but the systems built with a large investment of funds are not being utilized smoothly and are leading to failure.

Kim (2017) stated that a uniform MES construction strategy that does not take into account various factors such as the company's industry, production type, and scale presents many defects not only during the process but also after construction, so it is important to consider the company's industry, size, and type of production and level of informatization should be accurately identified and then built accordingly.

Choi (2018) said, "Convenience of using the system is recognized as a very important factor for business users who use the system directly, so when building a system, a vision providence for the effectiveness of system use and in-depth information and system education to ensure successful implementation are needed."

Kim et al. (2020) said that domestic smart factories are still at a basic level, so if a customized system is designed to suit the characteristics of the company, the productivity of companies can be improved by 20-70%.

Lee (2020) proposed a method to "design and build an MES with 7 program modules using 4 principles after analyzing field requirements to build an MES."

Kim (2022) applied improvements to the existing MES from the manager and field workers perspectives, resulting in quantitative improvements of 20% to 66% in terms of productivity, quality, cost, and delivery, and qualitatively, managers said that it has led to improved efficiency in processing work for field workers.

Park (2023) said that small and medium-sized manufacturing companies should make multifaceted efforts to create synergy through cooperation, collaboration, and capabilities of partners and suppliers in the process of introducing and operating MES.

Summarizing the above research results, most of them were about the causes of failure and improvement measures for MES introduction in large corporations or small and medium-sized enterprises. However, this study is significant in that it can provide implications and lessons to many small companies that are giving up on MES operation in that it suggests ways to introduce and revitalize MES through a case study of MES introduction failure and overcoming in small companies.

2.2 MES construction status

The Ministry of Trade, Industry and Energy and the Ministry of SMEs and Startups are strategically promoting the expansion and advancement of smart factories to innovate the manufacturing industry in line with the 4th Industrial Revolution era. This project aimed to build 30,000 smart factories by 2022. Looking at the distribution status of smart factories during that time, as shown in <Figure 2>, there are 7,139 units, exceeding the original target (5,600 units), and looking at the cumulative number by 2020, the number is 19,799 units, exceeding the target (17,800 units). The upgrading rate was 25.5%, a significant increase compared to 2019 (17.9%), and the cumulative upgrading rate (medium 1 stage more) by 2020 was 22.1%. The reason why the base of smart factories is expanding is that the domestic MES market size is growing rapidly, including an increase in MES construction projects and expansion of smart factory infrastructure, which is spurred by government policies.

Since small and medium-sized enterprises play a very important role in the national economy, the introduction and construction of smart factories in small and medium-sized manufacturing companies has become a key task. According to the Manufacturing Innovation Committee of the Korea Industrial Technology Association (KITA), it was found that the proportion of MES introduction in small and medium-sized companies was around 8% to 12%, and the introduction and construction of MES in small and medium-sized enterprises were not smoothly carried out. This problem has been mainly due to the lack of infrastructure for construction and operation, lack of know-how, high introduction costs, and difficulties in choosing suitable systems. Therefore, this study aims to derive a model for the successful introduction and operation of MES by analyzing the MES introduction cases of small companies and evaluating their effectiveness.

2.3 Study subject and method

The subject of this study is Company O, a small manufacturer in Daejeon. Since it is a company that has been actively operating MES and has accumulated operational experience for 3 to 4 years, we selected it as the target company to derive practical implications. We used the following methods to derive improvement measures for the MES introduction and operation of Company O.

Preliminary survey

To understand the current status of the MES introduction and operation of Company O, we conducted a preliminary survey. Through this survey, we analyzed the background of the introduction of the system, the current utilization status, and the causes of the difficulties.

In-depth interviews

In-depth interviews were conducted with 5 key personnel including the CEO and the head of the IT department who participated in the MES construction process. The interviews focused on the detailed causes of problems and difficulties experienced after the introduction of the system.

On-site observation

We observed the actual operation of the MES at Company O's site. This observation was aimed at understanding the practical utilization status of the system and identifying areas for improvement.

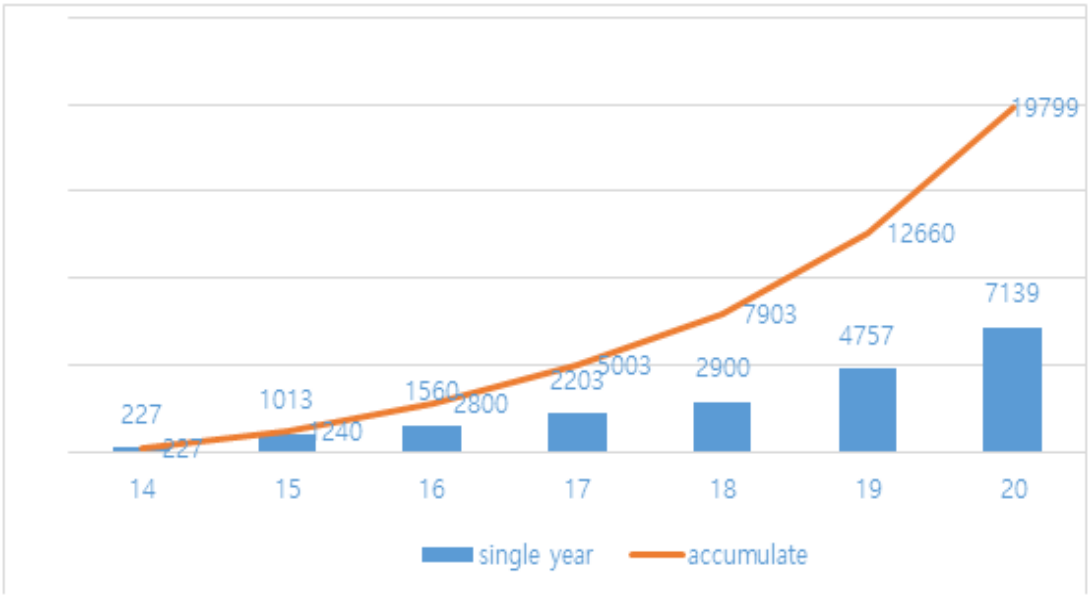
Analysis and improvement plan

Based on the data collected from the preliminary survey, in-depth interviews, and on-site observations, we analyzed the causes of the problems and difficulties in the existing MES operation. We then derived

improvement measures and plans to enhance the effectiveness of the system.

2.4 MES characteristics and benefits

MES is a comprehensive system that performs the function of controlling and managing various manufacturing processes, including production planning, scheduling, tracking, quality management, and inventory control. The core characteristics of MES are real-time monitoring, integration with ERP and other systems, and data-driven decision support. The benefits of MES include increased production efficiency, improved product quality, better resource utilization, and enhanced decision-making capabilities. Through the effective implementation and operation of MES, small and medium-sized enterprises can achieve significant improvements in their manufacturing processes and overall business performance.



<Figure 2> Smart Factory Introduction Status

3. RESULTS AND DISCUSSION

3.1 Current Status of Small Company O

First, looking at the employee status of Company O, <Table 1> shows. The main products include an auto lift, a CCTV camera raising and lowering device, an illegal garbage dumping monitoring device, a roadkill preventer, a track switching monitor, a disaster forecasting and warning device, a worker notification device, and a CCTV camera.

<Table 1> Company O employee status

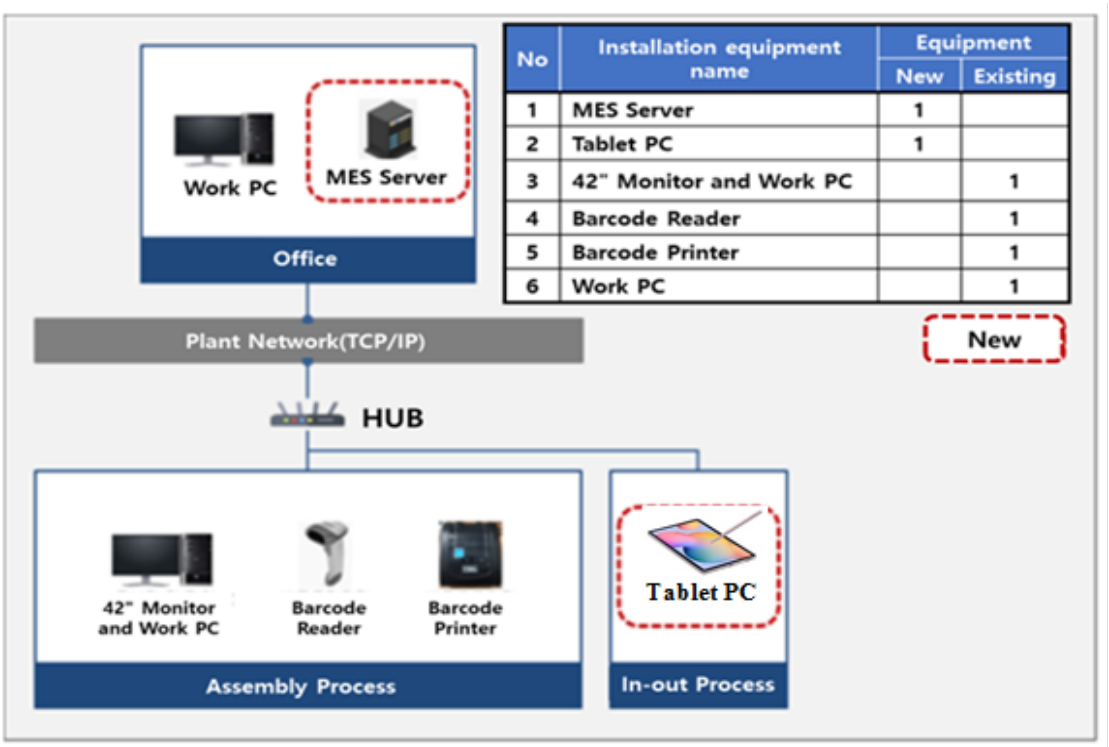
Division	Production technique	Affiliated research institute	Business management	Business Support	Total
Number of people	12	6	7	3	27
Experience (years)	5	5	7	5	27

3.2 Problems in Company O's MES operation

Company O's existing MES shows the following operational problems. First, due to the increase in product types and production volume, order management, production management, process time management, and inventory management could not be handled effectively. Second, production and shipment volume decreased due to late identification and procurement of materials and excessive design time due to poor drawings and cards. Third, time and manpower were wasted due to delays in locating inventory and finished products. Fourth, due to omission and inaccurate records, accurate process performance aggregation and process checking functions were insufficient.

3.3 Company O's MES construction details

Looking at the MES configuration previously built by Company O, it is shown in <Figure 3>.



No	Installation equipment name	Equipment	
		New	Existing
1	MES Server	1	
2	Tablet PC	1	
3	42" Monitor and Work PC		1
4	Barcode Reader		1
5	Barcode Printer		1
6	Work PC		1

<Figure 3> Company O's MES construction details

3.4 Ideas for improvement

In order to solve Company O's MES problems, the following ideas were derived as a result of a group discussion among working-level officials. First, the number of work instructions and drawings managed in a disorderly manner in the field, and management cards that describe special precautions and problems during production must be reduced. Second, a way to easily identify production delays that occur during the process must be found. Third, ways to efficiently identify spaces in cramped workspaces must be found. Fourth, so that all workers can easily check the location of parts within the warehouse, we must find a way to make them easier to find, such as mapping settings and attaching material numbers and location numbers for each warehouse location. Fifth, since most ordering companies are using a strategy of ordering only the appropriate amount to minimize inventory and then shortening the delivery period, it is necessary to find a way to establish a system that can respond quickly to the change in production process lines.

3.5 MES operation revitalization plan

Through analysis of field requirements, we sought ways to improve MES operation as follows. First, decide on an MES configuration range suitable for the production site of the auto lift, which is a CCTV camera lifting and lowering device, and the illegal garbage dumping monitoring device. Second, built on module-by-module information on additions and changes functions related to the standard menu structure of the MES screen and the configuration items for each screen to suit the company's circumstances. Third, based on the items that display the MES usage status, the presence/absence of data for each item and the performance compared to the plan are checked. Fourth, manufacturing costs are reduced by observing the real-time work progress according to the process, ensuring transparency of production performance and shortening the standard average process time and manufacturing lead time. Fifth, establish a standardization system for process work by preventing errors and mistakes in inputting production and quality data, checking real-time work progress according to the process, and identifying production performance and worker skill level according to the process. Sixth, work is carried out using on-site tablet PCs, bar codes, and sensors. Seventh, the screens for standard information management, sales management, production management, product management, and product management have been reorganized to simplify the use of the MES system by system administrators and in the field, and the work areas were divided standard information management, material management, and product management.

3.6 Summary of MES operation improvement results

It is not easy for most small-scale manufacturing companies to use a customized MES system tailored to special field conditions. But O case company solved problems that occurred while building and using a basic

MES supported by government policy and improved through advancement. The results of MES operation improvement through advancement can be summarized by dividing them into managers and production workers as follows. The results of MES operation improvement can be summarized by dividing them into managers and production workers as follows.

3.6.1 Administrator's side

First, deletion of duplicate management and automatic data storage

Second, data storage through automatic calculation of product name and quantity

Third, increased work efficiency due to customized optimization settings through ERP application

Fourth, real-time monitoring is possible on one screen.

3.6.2 Production worker side

First, instant aggregation of production process data through server and facility linkage

Second, the installation of tablet PCs, barcode readers, and stand-type desk computers increases work efficiency.

Third, immediate recognition through a sensor alarm when a process failure occurs.

Fourth, check the calculation of real-time data before and after the start of work.

Fifth, delivery and inventory quantity calculation/automatic inventory registration and sales (monthly/annual) calculation by using bar codes when shipping products.

3.7 IMPROVEMENT EFFECT

3.7.1 Quantitative effect

As shown in <Table 2>, Company O's MES improvement effects are shown a 25% improvement from the existing manufacturing lead time of 4 weeks to 3 weeks after the system change, and the existing process defect rate was reduced from 2.5% to 1.5% after the system change. Inventory of basic products was reduced by 57% from 35 million won to 15 million won after the system change. The existing delivery compliance rate was 80%, but after changing the system, it was 95%, an improvement of 15%. Additionally, the existing unused inventory cost was reduced from 15 million won per year to less than 8 million won after the system change, resulting in a 60% improvement.

<Table 2> Company O's MES improvement effects

Division	Key Indicators	Before Application	After Application	Improvement Rate (%)	Benefit
productivity	manufacturing leads Time reduction	4 weeks	3 weeks	25%	leads Time reduction
quality	Reduce process defect rate	2.5%	1.5%	40%	Reduce cost losses due to process failure
cost	Reduce product inventory	35 million won	15 million won	57%	Reduce inventory management costs
Delivery	Improved delivery compliance rate	80%	95%	15%	Cost savings due to delivery delays

3.7.2 Qualitative effect

The qualitative improvement effects are as follows. First, the waiting time for workers to use production management cards and draw information due to network problems in the field was reduced, improving information utilization and work accuracy. Second, work convenience for workers was improved as field workers entered and checked dimensions on their own, and work stress was reduced by using the memo function necessary for work. Third, by automatically entering overlapping management points, the efficiency of managers' material registration, drawing registration, and other order management was improved, thereby reducing managers' stress. Fourth, when transporting a product to the next process or checking the system completion button, it is automatically registered in the inventory management system,

so there is no need to check each item. You can check the location of the product in the process, the level of inventory, and even the exact production time. As a result, work conflicts and stress among work members were largely resolved.

4. CONCLUSION

This study attempted to analyze the problems of MES construction and operation in small manufacturers and suggest solutions through improvement cases. Company O, a case company, is a company that produces a variety of products, including an auto lift, a CCTV lifting and lowering device, and an illegal waste dumping monitoring device. Since 2018, it has established and operated the basic stage of the MES system to become a smart factory but has various types of products. Management is difficult due to the large number of input materials for the product, and as the type and production volume of products are increasing, the existing MES system could not effectively handle various processes such as order management, production management, process time management, and inventory management. Accordingly, Company O pursued a plan to improve the existing MES system by identifying and analyzing problems in the existing system based on the accumulated operational data. In order to solve problems in system operation, improvements were drawn for each process (management matter) and operation was improved as follows. First, when identifying problems, significantly supplemented the functionality by adding, changing, modifying, and deleting the existing system for each module. Second, desktop and tablet PCs were added to enable immediate data entry on-site. Third, promoted changes in information input processing and simplification of monitoring to enable label management for each rack in the warehouse. As a result, quantitatively, it resulted in an improvement of 15% to 57% in terms of productivity (P), quality (Q), cost (C), and delivery (D), and qualitatively, it brought about an improvement of 15% to 57% for both managers and production workers. Work has become much easier and more efficient than before. The significance of these research results is that they suggest a good plan for introducing MES in small businesses or revitalizing MES that is dying. In the future, it is believed that it will be necessary to classify small businesses by industry and devise ways to introduce and improve MES, or to research key considerations to successfully advance from the basic stage to the advanced stage of smart factories.

5. REFERENCES

Asemi, A., Tavakoli, F. & Houshangi, N. (2022). The Psychological Effect of the Librarians' Uniform Color on Occupational Engagement. Library Progress (International), 42(2), 242–251.

Choi, J. H. (2018). *The impact of MES (production management system) adoption factors on small and medium-sized enterprises' business performance (Doctoral thesis).* Kangwon National University Graduate School, Chuncheon.

Jang, S. Y., & Lee, M. S. (2013). Development of C/S-based MES system (c-MES Basic) for small businesses. In *Proceedings of the Fall Conference of the Korean Society of Manufacturing and Manufacturing* (p. 206).

Jeong, S. W., & Lim, H. G. (2021). Analysis of the current status of AI/Big Data-based smart factory technology for effective display manufacturing. *Journal of the Korea Information and Communication Society*, 25(3), 471–477.

Jeong, Y. K., Cho, M. B., Jeon, I., Noh, S. D., Cho, H. J., & Cho, Y. J. (2013). Study on production information system (MES) introduction strategy for small and medium-sized manufacturing companies (II) - Customized introduction guidelines using rule base. *Journal of the Korean Society of Precision Engineering,* 30(2), 206–215.

Joo, H. T. (2008). MES solution trends and construction project success strategies. ie Magazine, 15(3), 26–32.

Kim, H. D. (2017). *Study on success factors through MES implementation cases of small and medium-sized manufacturing companies (Master's thesis).* Sang-myung University Graduate School, Cheonan.

Kim, J. H. (2022). Study on MES operation and improvement case studies in small-scale manufacturing companies: Focusing on company D, a laser toll processing company (Master's thesis). Hanbat National University Graduate School of Industry, Daejeon.

Kim, S. Y. (2020). Proper on-site customized operation system. Magazine Hankyung. Retrieved from https://magazine.hankyung.com

Kim, Y. J. (2000). Production management system with an efficient client/server-based structure (Master's thesis). Hoseo University Venture Graduate School, Cheonan.

Kumar, V., Singh, N., Nathawat, B.D.S. and Kumhar, D.R. (2021). Management of Early Leaf Spot (Cercospora arachidicola) of Groundnut in Rajasthan. *Legume Research*. https://doi.org/10.18805/LR-4708

Lee, H. S. (2014). Development of process modeling and similarity measurement methodology for manufacturing execution system function recommendation (Master's thesis). Pusan National University Graduate School, Pusan.

Lee, J. G. (2020). *A case study of MES construction in small company D belonging to the six major root industries (Master's thesis).* Hanbat National University Graduate School of Industry, Daejeon.

Lee, J. Y., Cho, M. B., Park, Y. H., Lee, E., Noh, S. D., Cho, H. J., & Choi, S. W. (2013). A study on the production informatization (MES) introduction strategy of small and medium-sized manufacturing companies (I) - Diagnosis and evaluation of the level of production informatization. *Journal of the Korean Society of Precision Engineering*, 30(2), 194–205.

Lee, S. W., Lee, J. K., Nam, S. J., & Park, J. K. (2011). Example of application of field information collection system for MES implementation. *Journal of the Korean Society of Mechanical Engineers*, A, 35(9), 1063–1070.

Lee, W. S. (2008). A case study on the establishment and diffusion of a manufacturing execution system (MES) (Master's thesis). Graduate School of Business, Seoul National University, Seoul.

Ministry of SMEs and Startups. (2021). Ministry of SMEs and Startups achieved 20,000 smart factories distributed. Retrieved from https://www.korea.kr/briefing/pressReleaseView.do?newsId=156431980

Park, H. J. (2017). Success story of a smart factory that led to the 4th revolution in the Chungnam region. Jungdo Ilbo. Retrieved from https://www.joongdo.co.kr

Park, J. S. (2023). *A study on the selection of key factors for effective MES construction in small and medium-sized manufacturing companies (Doctoral thesis).* Myongji University Graduate School, Seoul.

Sachdeva, G., Ganjoo, M. & Borah, T. (2024). The Impact of Digital Media Consumption on the Academic Performance of Children in the Global South: A Bibliometric Analysis Using Scopus Database. Library Progress International, 44(2), 6-18. https://bpasjournals.com/library-science/index.php/journal/article/view/235

Semara, I. M. T., Sunarta, I. N., Antara, M., Arida, I. N. S. & Wirawan, P. E. (2024). Tourism Sites and Environmental Reservation. *International Journal of Environmental Sciences*, 10(1), 44-55,

Shi, T., Jeong, Y. K., Noh, S. D., Cho, H. J., Cho, Y. J., & Choi, S. W. (2012). Study on MES application procedures for small and medium-sized manufacturing companies based on systems engineering. In *Korean CDE Society conference proceedings* (pp. 240–245).

Shiting. (2014). *Study on M&S application method for MES introduction plan and effect analysis (Master's thesis).* Sungkyunkwan University Graduate School, Seoul.

Sim, H. S., & Won, J. Y. (2016). Construction and effect analysis of field-customized MES. *Journal of the Korean Society of Management Engineering*, 21(2), 57–71.

Talreja, B., & Agashe, A. (2024). Digital Library Transformation's Role in Enhancing Student Relationship Management Systems in Nagpur's Educational Institutions. Library Progress International, 44(2), 1-5. https://bpasjournals.com/library-science/index.php/journal/article/view/234

Tiwari, S. K., Tiwari, P., & Anand, N. (2023). Impact of Artificial Intelligence to Automate Management of Employee Benefits. *Pacific Business Review (International)*, 16(2), 25-33.