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The Method of Structuring Production Logistics Systems in Smart Factories of SMEs

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Abstract

This study suggests the method of structuring production logistics systems in the middle level of smart factories. The managing module of the systems consist of sales management, purchasing management, production process management, quality management, and inventory management and basic information management. This method can increase work effectiveness because it can produce customers' order data formats and confirm estimates in real time through sales management. It is possible to share correct working time, order change contents and loading processes in real time in purchasing and production management, followed by decreasing input time and increasing production effectiveness. Furthermore, it is also able to decrease working time based on computerized information pertaining to the quality within quality management, followed by a quick and efficient customer response.

Keywords: *SMEs, Production Logistics System, Smart Factory*

1. Introduction

The medium and large sized enterprises under the management environment of small quantity batch production are trying to enhance the competitiveness through diversification of goods processing and differentiation of technology. There are tendencies of aging of the skilled and experienced workers, and increasing costs due to deterioration of manufacturing facilities and increasing items of maintenance in production of small and medium sized enterprises (SMEs). Therefore, the competitiveness of SMEs in domestic and global markets has been lowered gradually [1].

SMEs need to shorten the duration of product development and take R&D in production and logistics system in order to sustain the competitiveness against poor surroundings in the markets. While high quality researches in the areas of procurement logistics, sales logistics, reverse logistics and logistics outsourcing are accessible, literature on product processing logistics within a plant or an establishment is rare. According to the literature on product processing logistics, optimization of product processing logistics will bring improvement of competitiveness in SMEs through

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improvement of productivity, costs saving, shortened delivery time, and other advantageous effects [2].

SMEs would respond positively to new surroundings of markets and add increased value if the manufacturers integrate and harness IT technology in product processing. The integration of IT technology and goods processing is an essential element which overcomes the limits of growth in quantity inputs. Also, it changes the paradigm of production method and raises the added value. IT convergence of South Korean manufacturers is the first step towards this technology, but developed countries such as Germany, Japan and U.S. have already implemented the structure production logistics systems in smart factories such as automated, intelligent manufacturing equipment. They focus on technological development of the fourth industrial revolution and perform distinguished support for manufacturers. Through "Smart Manufacturing Revolution 2025", the Korean government is currently supporting manufacturers which will produce 30,000 smart factories by 2025. The volume of smart factories in Korea is predicted to increase steeply from U$ 2.4 billion in 2012 to U$ 4.4 billion [3].

There is a major technology such as cyber physics systems (CPS), robotics, 3D printing, Internet of things (IoT) and cyber security technology. Manufacturing businesses are changing rapidly as the major basic technologies are applied to all areas of manufacturing processes. The innovative strategy of manufacturers based on smart factories is performed in developed countries from the national viewpoint such as U.S. China, Japan, Germany, France and Korea. Smart factories are divided into the following steps: unapplied step of ICT, the step of smart ready, the step of smart ready+ and the step of smart advance. Conglomerate has a high level of manufacturing technology over one of the developed countries; however, the SMEs are different. As a result, they should perform the technology step by step. It is difficult to make the introduction and direction of smart factories in SMEs. Therefore, the objective of this study is to structure a middle level steps as the method for making smart factories in SMEs [4].

2. Production Logistics Systems of Smart Factories

2.1. Production Logistics System

Production logistics is defined as all activities concerned with supply of raw materials inputted in production processes such as materials, half-finished accessory goods and parts in factories. In an industry such as automobile and home electronic appliances, materials are used in various parts to produce finished goods. It is important to manufacture efficiently and implement sound logistics plans in supply chain management between manufacturers and suppliers. There are three reasons for this: one is to maintain many suppliers in supply chains, another is the fact that production and logistics activities among suppliers are closely related with production activities of finished goods, and the third is that the activities have an influence on productivities, efficiency and cost competitiveness of finished goods. Therefore, they need to form and implement plans of production and operations in production and logistics activities of suppliers which exist in the supply chains [5].

2.2. Introduction of Smart Factory

Smart factory defines that the factories integrate whole processes such as plans, production and distribution through optimizing human and physical resources as well as combine Internet and communication technology and apply customer needs to production in real time. They supply high levels of automated services and intelligent infrastructure based on convergence of technology such as IoT (Internet of Things), 3D print, sensor, big data and advanced robotics.

Smart factory implies the inclusion of vertical integration based on production equipment of factories and horizontal integration based on value chain associated with product development initiated from customer needs.

Vertical integration is explained as follows: the goal is efficiency of production, it acquires the signals through sensors and devices in various facilities which produce products, and it controls facilities through control technology such as programmable logic controller (PLC) and human machine interface (HMI). Horizontal integration starts from a market research and a product plan in order to acquire customer needs, produce goods after R&D for product development. Also, it functions as a process design in order to meet customer needs and delivers goods to customers. Figure 1 represents the scopes of vertical and horizontal integration of smart factories [4].

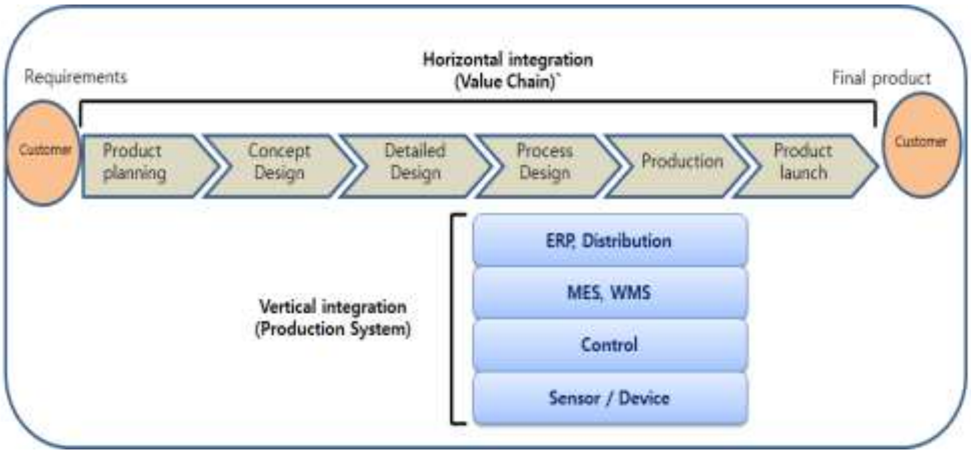

Figure 1. Scopes of Smart Factory

There are four levels of ICT application and usage in smart factories and almost all SMEs are located in the first level. The level of ICT application is concerned with systems based on EXCEL usage. The basic level is informative level based on lot tracking and verifies the flow of materials in real time. The middle level is to exchange real time information between materials and facilities through information generated automation based on ICT and performs optimization of factory operations on the basis of result information in real time. The highest level is concerned with intelligent factory operation systems based on 4M (man, machine, material and method) + 1E (equipment) operations on the basis of IoT [3, 6].

2.3 The Key Technology of Smart Factories

The key of smart factories realization is to connect internal and external resources in factories based on industry IoT technology and to construct platform for optimization in production and service. Technology of platform consists of real time collection of production data, big data production analyses and usage of the big data. Real time collective technology of production data is performed by middleware and production devices, followed by big data analyses, process capabilities, testing for quality variables, prediction and analyses of facilities reliability and analyses of simulation and scheduling. The integrated management of monitoring and analyzing production resources is performed by platform OS and related modules [3].

It is possible to judge component technology in realizing technology of smart factories such as factory automation, flexibility and integration manufacturing systems, and smart factory. Recently, there is a lot of discussion about technology. Within the scope of technology, convergence, Internet, cloud, big data, and mobile technology, there are no limitations; they can all be utilized in manufacturing and operations management. There are eight key technologies in smart manufacturing technology in South Korea. They are smart sensor, CPS, 3D printing, energy saving technology, IoT, cloud, big data and hologram. The three core factors in technology of smart factories are application, device and platform. It is important to be flexible and cooperating within digital, real world and selected structure of technology factors like engineering and manufacturing in integrated environment [2].

2.4. Case Study for Structuring Production Logistics Systems in Smart Factories

Rio Tinto, as the world's first, started operations of Processing Excellence Centre (PEC) in mining industry in Brisbane, Australia. The center focuses on production improvement and safety enhancement based on prediction and prevention of an engine breakdown and estimation based on large data collected and stored by sensors attached in fixed and mobile mining operating devices. GE makes flexible multi-module factory in new concepts and they support production and processing of various products such as airplanes, electrics, gases, transport business goods, jet engine and parts of trains which are all connected with "Brilliant Factory". The factories prevent a sudden shutdown and seek optimal production and quality maintenance through industrial IoT and big data which are connected with supply chains, service networks and distributing networks and shared with real time information among facilities of factories. ZARA uses information network in the shops. When customers visit, the networks send information to designers twice a day using cameras in the shops. ZARA stows the data such as buying statistics data of customers, a daily business analyzing report including return ratio and the analytical results of sales ranking and they perform market segmentation to reflect customer needs in the process to choose color and pattern [4].

3. The Method of Designing Production Logistics Systems in Smart Factories of Chinese Manufacturers

There are a few problems in production logistics systems of small and medium sized manufacturers. First problem is the result of not being able to share stock information in real time because the production data in the factories is collected manually. Second, there is a problem in working processes because they perform work cooperation by e-mail (documents) and telephone (conversation). And the final problem is just-in-time delivery of goods because they manage after-sale service, stock management and production data in EXCEL. Production logistics systems of many small and medium sized manufacturers are manually managed in the areas of production plans and working orders and as a result, production processes are not managed effectively resulting in after-sale service problems.

This study has developed production logistics systems of small and medium sized manufacturers in the first-middle level of smart factories. The production logistics systems of smart factories structured in this study consists of sales management module, a production management module, a quality management module, a stock management module and a basic information management module. Figure 2 shows functions of each module and processes among modules in the systems [7-9].

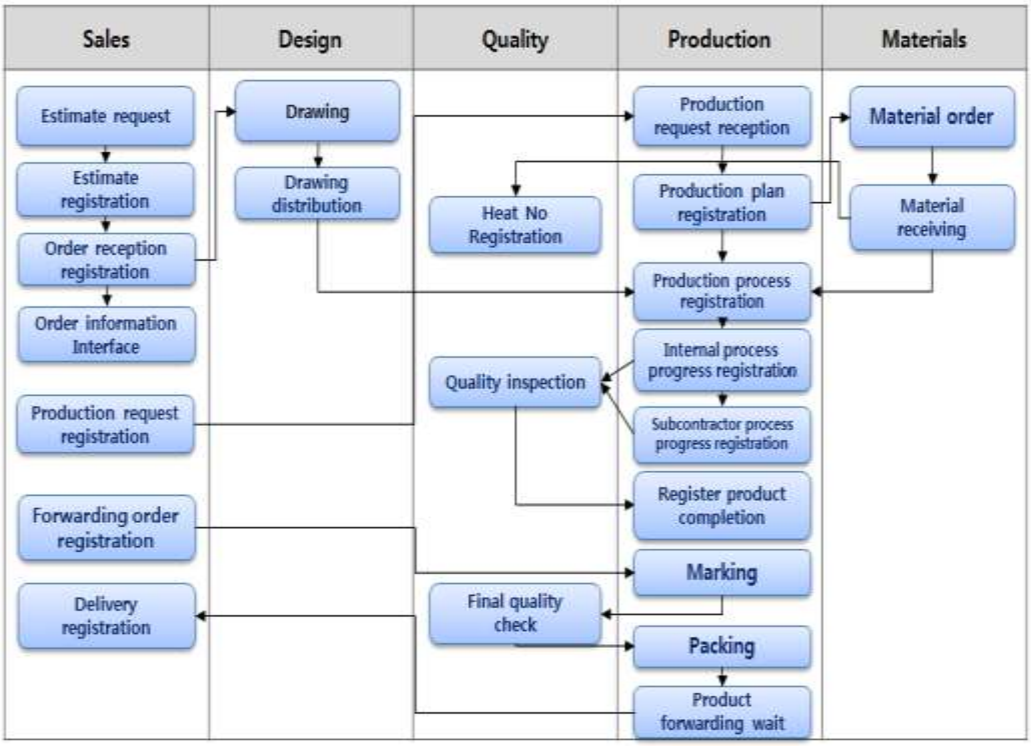

Figure 2. Module and Process in the System

Figure 3 and Figure 4 represent and consist of software and hardware in the systems.

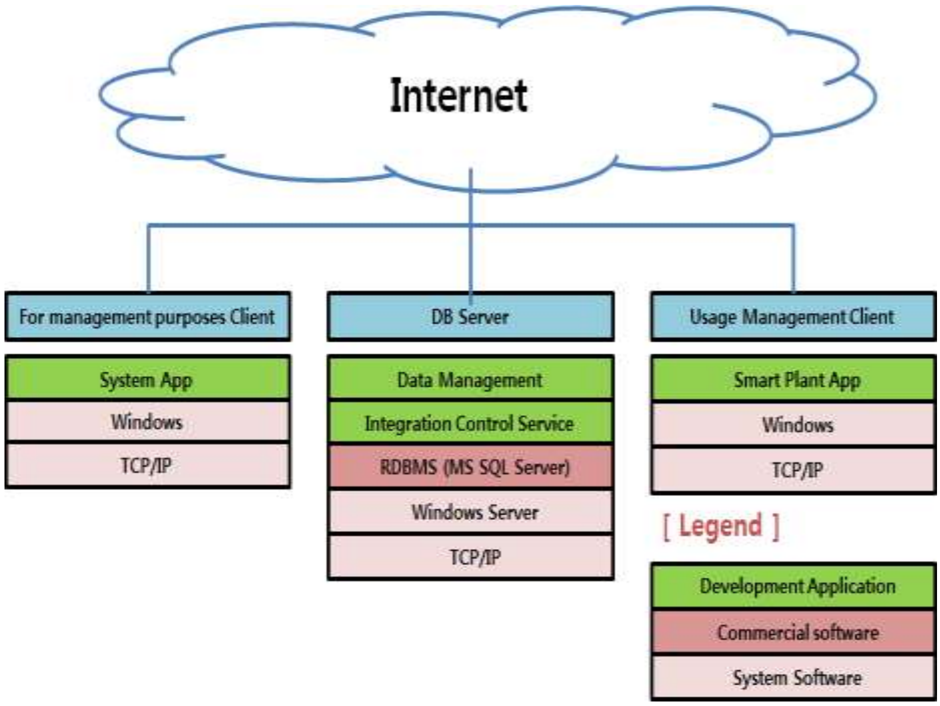

Figure 3. Consists of Software in the System

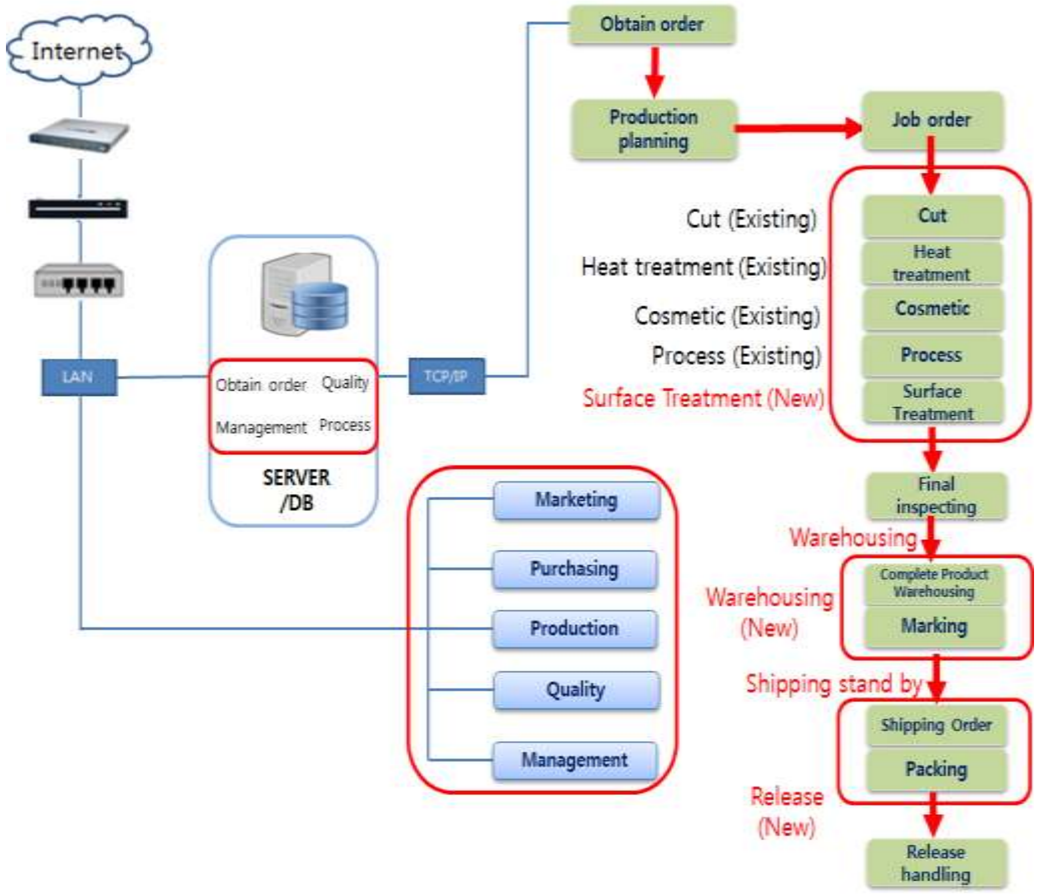

Figure 4. Consists of Hardware in the System

Consist of software system is made up of management client, DB server and usage management client, and the map of hardware is composed of the process of production logistics systems in smart factories.

4. The Structure of Production Logistics Systems in Smart Factories of SMEs

It is difficult to share information of final goods in real time because production logistics systems of small and medium sized enterprises (SMEs) produce goods in factories and manually sum up the data. In addition, when they discuss inter-departmental issues, there are some problems in cooperation because the workers are performing their duties based on documents and conversations. Moreover, there are two additional problems based on inefficient quality management: one is concerned with post hoc management and the other is connected with just-in-time delivery of goods because the stock management and production management are based on EXCEL.

This study develops the first step model of smart factories concerned with production logistics systems of SMEs. The production logistics systems consist of a basic information management module, a production management module, a stock management module, a quality management module and so on.

1) The Development of a Sale Management Module

Figure 5 and Figure 6 show forms of loading orders based on EXCEL (MS office) and order management which manufacturers write in the present. Figure 7 and Figure 8 represent a sale management module of smart factory production logistics systems in the present.

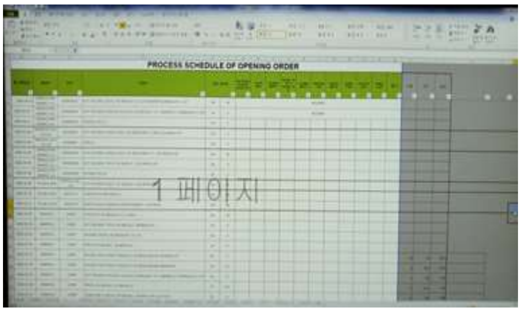

Figure 5. and Figure 6. Forms of a Sale Management based on EXCEL

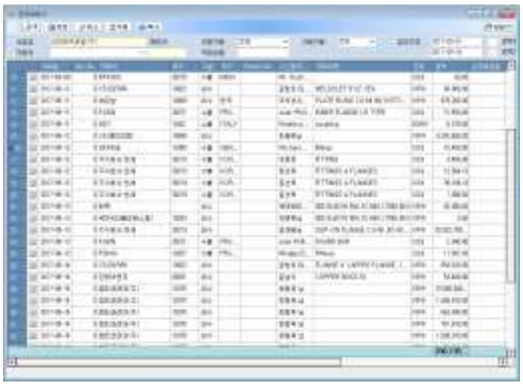
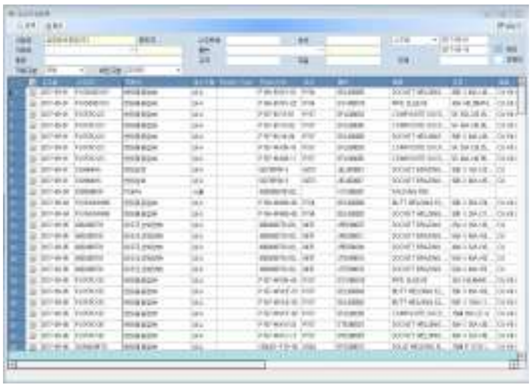

Figure 7. and Figure 8. Sale Management Module of Smart Factory Production Logistics Systems

There are two problems in the present method of sales management: one is data sharing and history management for orders because of manual operation of preform inquires. Second one is inter-departmental collaboration when orders are changed because the changes are not shared in real time. It is possible to automatically request exchanges of orders in a sale management module of smart factories because of sharing standardized information between users based on preforms inquires and reversion management and sharing information which request exchanges of orders in the workplace in real time [7-9].

2) The Structure of a Production Management Module

Figure 9 and Figure 10 show forms of production plans and present processes of operations in SMEs. Figure 11 and Figure 12 represent a production management module of smart factory production logistics management systems. The present method of production plans decreases productivity because production plans after orders and work order systems are performed in manual operations. A production logistics module of smart factories can be automatically managed by production plans and work order systems based on order data. In addition, it is possible to manage optimal delivery and to increase customer response service because of managing production processes in real time.

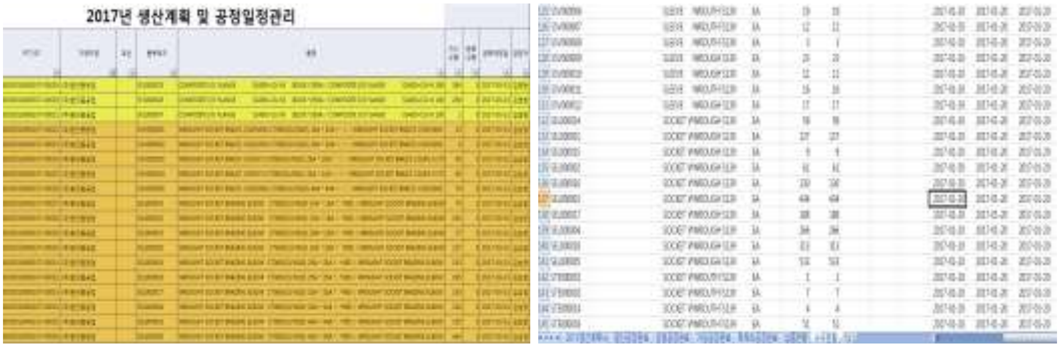

Figure 9. and Figure 10. Forms of Production Management based on EXCEL

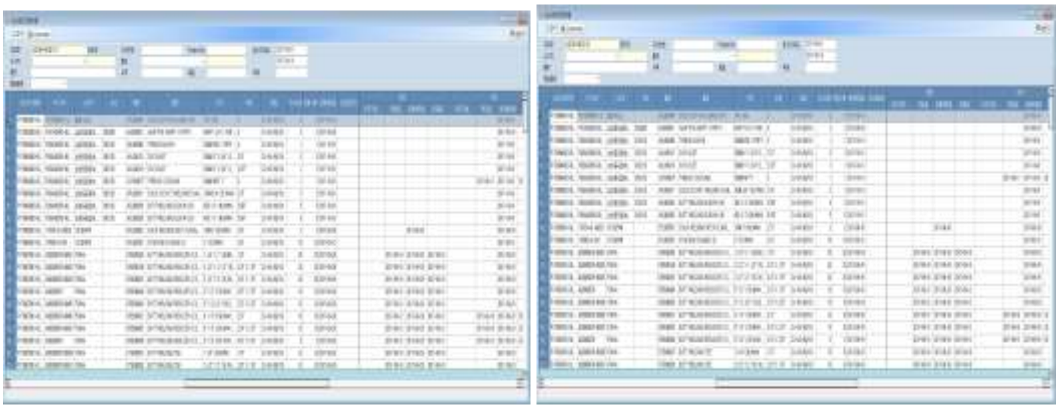

Figure 11. and Figure 12. Sale Management Module of Smart Factory Production Logistics Systems

3) The Structure of a Quality Management Module

Figure 13 and Figure 14 show manual forms of survey reports and heat treatment information. Figure 15 and Figure 16 represent a quality management module of smart factory production management systems. Workers manually manage heat treatment information and survey reports in factories. And due to the fact that it is difficult to instantly respond to customer requirements, the improvement is urgently required. A quality management module can provide customer satisfaction; decrease defective rates and increase work productivity because it is possible to instantly respond to customer requirements based on processing quality management by computer systems such as heat treatment information management, survey reports and inferior goods management.

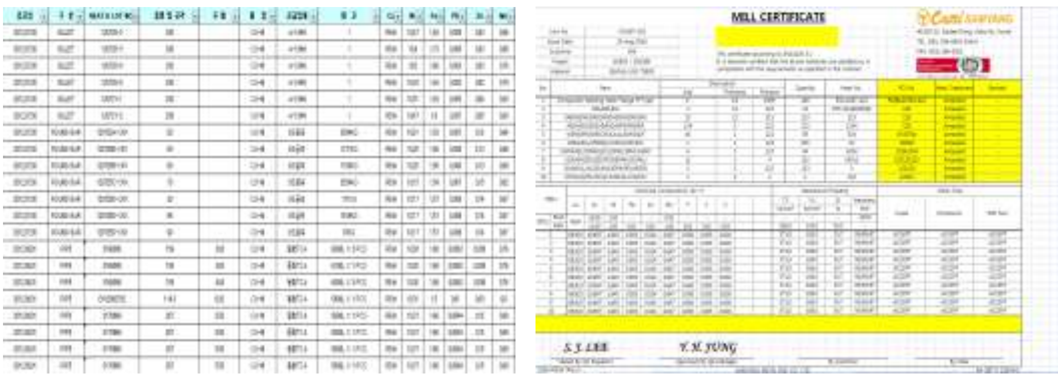

Figure 13. and Figure 14. Forms of Quality Management based on EXCEL


Figure 15. and Figure 16. Quality Management Module of Smart Factory Production Logistics Systems

4) The Structure of a Stock Management Module

Figure 17 and Figure 18 show present daily reports and stock management of signboard forms. Figure 19 and Figure 20 represent a stock management module of smart factory production management systems. It is not possible to have real time stock management because of manually recording stock on signboard in the present method of stock management. However, it is possible to correctly manage stock in factories because workers can identify present stock in a stock management module of smart factories.


Figure 17. and Figure 18. Forms of Stock Management based on EXCEL

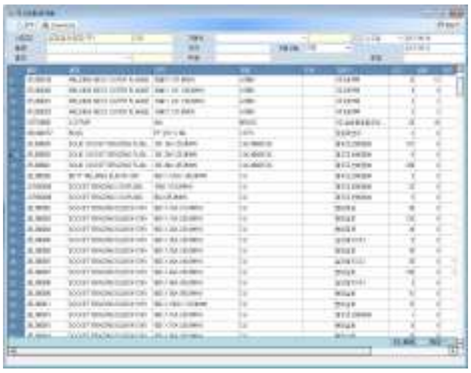
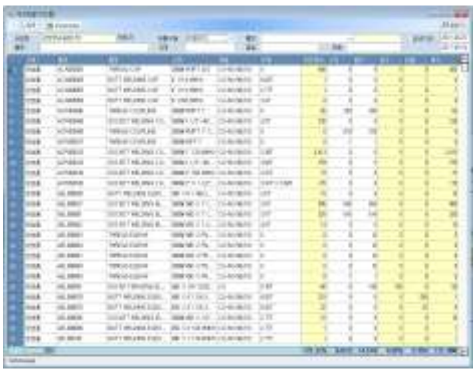

Figure 19. and Figure 20. Stock Management Module of Smart Factory Production Logistics Systems

5. Conclusion

On the basis of environmental change, conglomerate is enhancing competitive advantages because of applying different technology to production fields and various manufacturing methods, but competitiveness of small and medium sized manufacturers is decreased in internal and external markets.

This study suggests the method of structuring production logistics systems in the middle level of smart factories to analyze production fields in a map of logistics processes in production fields based on comprising hardware and software. In addition, this study classifies functional modules of the systems and defines specific functions of each module. The managing module of the systems consist of sales management, purchasing management, production process management, quality management, inventory management and basic information management. They can increase work effectiveness because of making order data formats of customers and confirming estimates in real time through sales management. It is possible to share correct working time, order change contents and loading processes in real time in purchasing and production management, followed by decreasing input time and increasing production effectiveness. It is also possible to decrease working time based on computerizing information related with quality in quality management, followed by efficiently performing quick response to customers. Therefore, the system manages production logistics fields of small and medium sized manufacturers in real time and as a result, they improve work processes, save production cost and improve customer service. Future research direction is in the area modeling development of production logistics systems of smart factories for small medium sized firms and the management of complex systems in global environment.

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