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AI Smart Factory Model for Integrated Management of Packaging Container Production Process

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Abstract

We propose the AI Smart Factory Model for integrated management of production processes in this paper .It is an integrated platform system for the production of food packaging containers, consisting of a platform system for the main producer, one or more production partner platform systems, and one or more raw material partner platform systems while each subsystem of the three systems consists of an integrated storage server platform that can be expanded infinitely with flexible systems that can extend client PCs and main servers according to size and integrated management of overall raw materials and production-related information. The hardware collects production site information in real time by using various equipment such as PLCs, on-site PCs, barcode printers, and wireless APs at the production site. MES and e-SCM data are stored in the cloud database server to ensure security and high availability of data, and accumulated as big data. It was built based on the project focused on dissemination and diffusion of the smart factory construction, advancement, and easy maintenance system promoted by the Ministry of SMEs and Startups to enhance the competitiveness of small and medium-sized enterprises (SMEs) manufacturing sites while we plan to propose this model in the paper to state funding projects for SMEs.

Keywords: *Packaging container, AI, Smart Factory, integrated management, production process, cloud, SMEs*

1. Introduction

As a decrease in labor became a serious issue in the manufacturing industry, smart factory technology, which combines information technology and the manufacturing business, began to attract attention as a solution [1]. Smart factory is defined as a factory in which "vertical integration based on the factory's production facilities and horizontal integration based on the product development value chain starting with customer requirements" is implemented. Vertical production system integration acquires signals through sensors and devices in various facilities where products are produced, and controls facilities through control technologies such as Programmable Logic Controller (PLC) and human machine interface (HMI), while it includes a concept that can be organically managed from Manufacturing Execution System (MES) to manage the production process and Warehouse Management System (WMS) for warehouse management to Enterprise Resource Planning

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(ERP) at the top level. The key difference between the smart factory and the existing production system lies in the establishment of a light and flexible production system, that is, an "autonomous distributed control production system". Smart Factory goes beyond the existing concept of factory automation, and features systems that can interconnect all factories, such as moving one factory. IoT, a core technology, is an intelligent technology and service that connects all things to the Internet to exchange and collect information [2]. This means that by attaching sensors and memory to materials and semi-finished products as well as mechanical facilities, ordering the facilities on an order, it is possible to self-diagnose bottlenecks in the production process and flexibly determine the optimal production path [3]. In conclusion, a smart factory is a high-tech intelligent factory centered on people that integrates all production processes from product planning to sales with information and communication technology to produce customized products with minimal cost and time [4].

2. Related Studies

Manufacturers who produce food packaging containers using plastics and biodegradable resins are classified as chemical manufacturers in the inferior industry, and there have many difficulties in establishing the production information management system compared to general manufacturers. Accordingly, manufacturers that produce food packaging containers using plastic and biodegradable resins have an urgent need to adapt faster to the rapidly changing digital information environment, while in particular, the production of food packaging containers and raw material manufacturing sites at a glance is required to eliminate unreasonable elements of the production process, improve quality, and innovatively reduce manufacturing costs.

Large corporations have built and operated supply chain management systems to strengthen their competitiveness, but they face an environmental factor that is difficult to apply in the production of small varieties and food packaging containers using plastic and biodegradable resins to cope with rapid changes in climate and seasonal factors and tastes, packaging methods and demand, and urgent orders based on unspecified cycles.

In a study on the implementation of a real-time integrated platform for the production of food packaging containers by Kim chi-gon, Park Jong-yeol, and Park Dae-woo, configuration methods for a real-time integrated platform is proposed to improve productivity and reduce costs by sharing production management information and warehouse/distribution management to minimize storage and distribution warehouses that must be secured by main producers, production partners, and raw material partners for storing the produced food packaging containers and raw materials. It also is to establish and share production management plans for food packaging containers and raw materials in relation to the production of small-volume, multi-variety food packaging containers between the main producer, production partners, and raw material partners, and to monitor and share the production progress of food packaging containers and raw materials for timely delivery according to changes in unspecified demand due to climate and seasonal factors [5].

Designing a data collection model to collect diverse data from installed sensors by establishing an artificial intelligence-based smart factory at the manufacturing site of SMEs illustrates an information collection process in which data is collected from sensors installed on various manufacturing equipment built on manufacturing sites of SMEs and modeled and serviced product data reflecting customer requirements.

In order to efficiently collect data to be collected at the manufacturing site, the following requirements must be met: First, existing facilities and equipment built at the manufacturing site must have a connection line that can be replaced or upgraded. Second, a protocol and communication interface capable of linking heterogeneous systems should be established. Third, information must be transmitted and received through communication networks such as wired/wireless, RFID, and Wi-Fi. Fourth. it should be possible to relocate and utilize the equipment built at the manufacturing site. Fifth, it is necessary to protect the information transmitted and received between devices. Various innovations such as artificial intelligence (AI), big data, and IoT are taking place [6]. Therefore, it is possible to link support with R&D, education, and commercialization consulting for manpower nurturing by utilizing the data analysis results collected through equipment built in SMEs manufacturing sites [7].

3. AI Smart Factory Model

Figure 1 shows the configuration diagram of the integrated production management for AI Smart Factory Model as an integrated platform system for food packaging containers, consisting of the main producer platform system (100), one or more manufacturer platform systems (200), and one or more raw material partner platform systems (300).

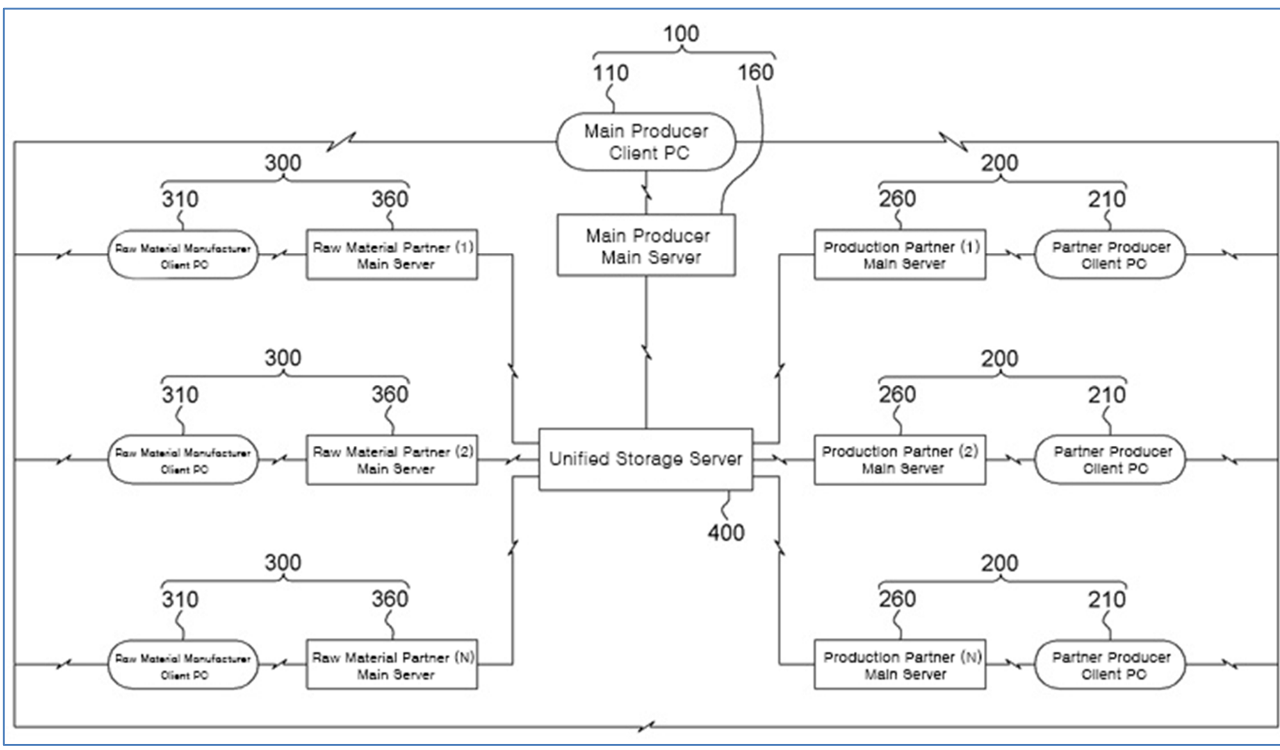

Figure 1. Integrated production management system for AI Smart Factory Model

Each of the three systems has an integrated storage server platform (400) that is infinitely scalable with flexible systems that can extend client PCs and main servers at scale and has integrated management of overall raw materials and production-related information. The integrated storage server platform accumulates big data by storing information at each stage, completing AI Smart Factory that connects artificial intelligence reasoning and business decision-making.

Figure 2 shows the hardware configuration of the integrated production management AI Smart Factory Model, which collects production site information in real time by using various equipment such as PLCs, on-site PCs, barcode printers, and wireless APs. The data from MES and e-SCM are stored in the cloud database server to secure security, and are accumulated as high availability of data and big data. The detailed process consists of 9 steps.

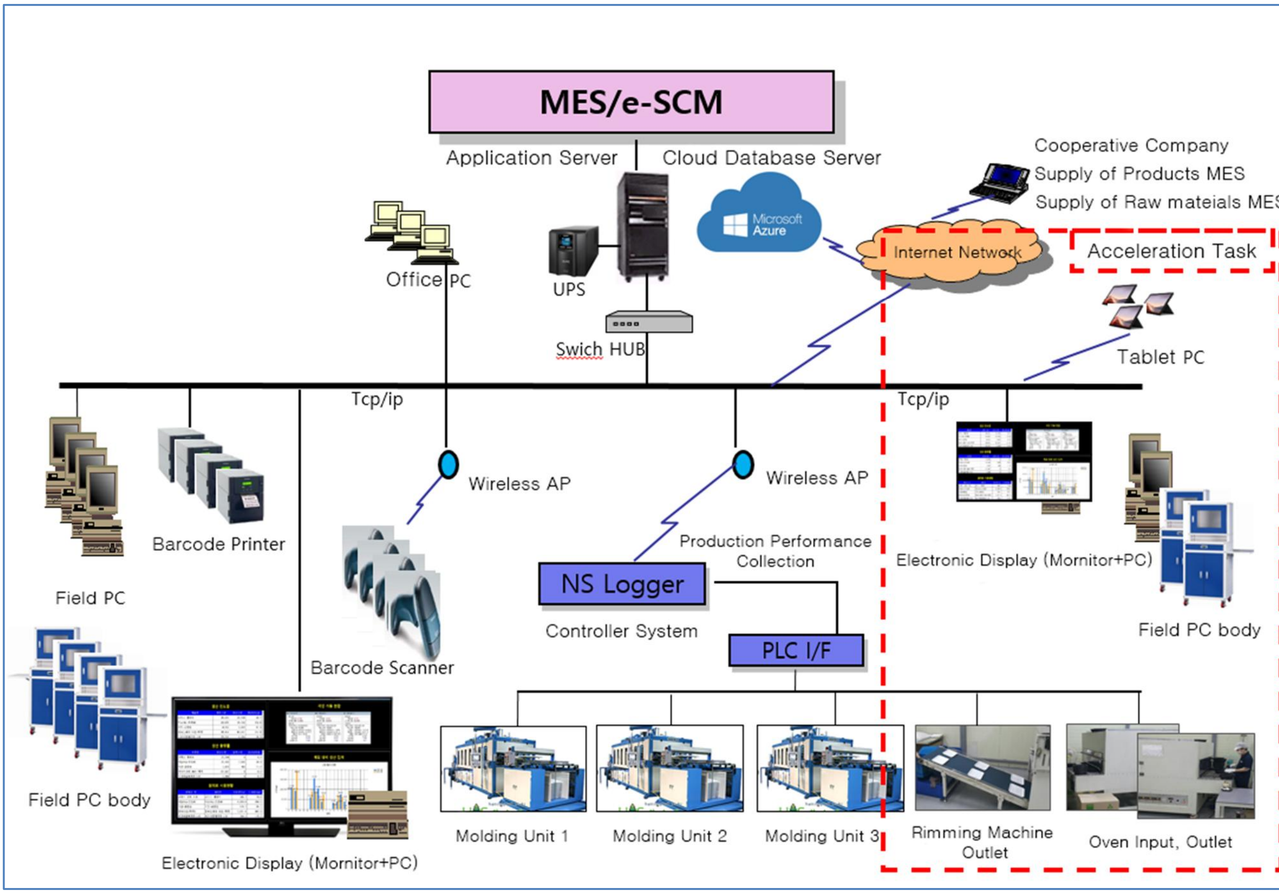

Figure 2. H/W configuration of the integrated production management AI Smart Factory Model

○ Production site information is collected in real time by utilizing various equipment such as PLC, field PCs, barcode printers, and wireless APs.

○ In the process of inputting raw materials, barcode scanners and on-site PCs are used to manage information on raw materials input by lot and operate in connection with the management of manufacturing history of products.

○ The raw material warehousing and releasing process can be managed by referring to and managing product shipment information to storage warehouses or ordering customers by utilizing barcode equipment, mobile tablet devices, and on-site PCs.

○ Information interworking with sub-manufacturing systems collects counter information in real time through interworking with PLC system and NS Logger.

○ Through the enhancement project, automation equipment was added to the outlet of the reaming machine and the input/outlet of the oven machine, which are the follow-up processes, to reduce the defect rate caused by manual work, thereby increasing production while on-site PCs are added to collect data from subsequent processes, and interface processing between NC Logger and automation equipment PLCs is executed.

○ By installing an on-site electronic sign board, identifying real-time production status and production volume control is applied.

○ By adding tablet PCs, efficient delivery management is achieved by identifying production progress and inventory at any time through e-SCM regardless of location. The target user is the person in charge of production, sales, and outsourcing, and can be added as necessary.

○ In the application server, the MES application, which collects counter information of each facility from the NS Logger and transmits it to the cloud database server, and e-SCM web application are operating, while it is connected to the UPS in consideration of the server down from the factory's unstable power supply.

○ The data from MES and e-SCM are stored in the cloud database server to maintain advanced security and high data availability.

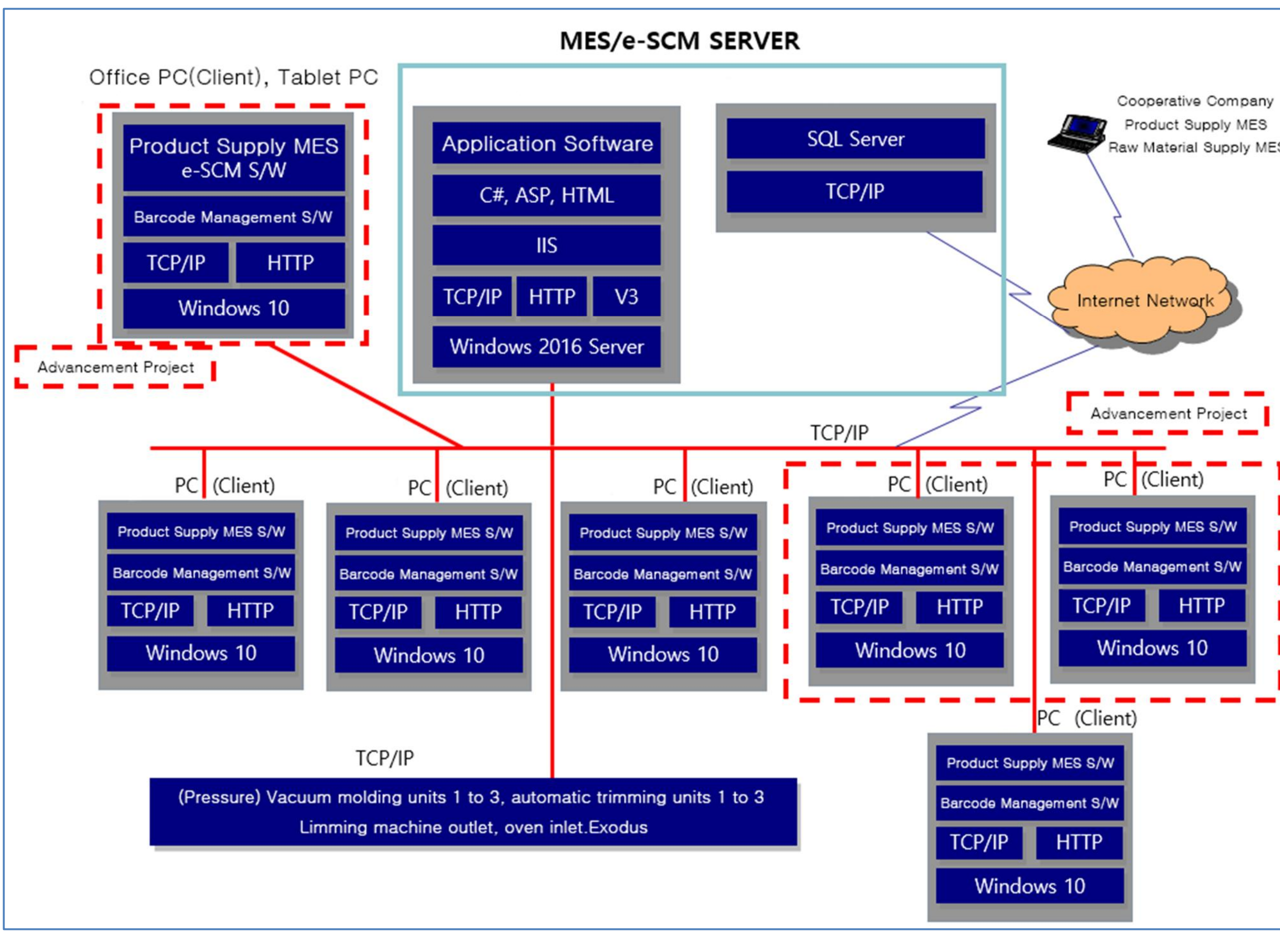

Figure 3. S/W configuration of the integrated production management AI Smart Factory Model

Figure 3 shows the detailed process of AI Smart Factory Model S/W consists of 6 steps. The key elements of this are MES/e-SCM SERVER, Client PC, Database, Application Software, Product Supply MES e-SCM Software, Barcode Management S/W, field installed equipment.

○ The MES/e-SCM system is divided into product supply MES S/W and e-SCM S/W, while MES S/W as a program used in internal production sites, consists of standard information management, sales management, production management, process management, product management, quality control, raw material management, packaging management, and outsourcing management.

○ The e-SCM consists of MES remote management, product supply management, and raw material supply management, while it is developed on a web-based basis making it easy to access the system using tablet PCs as well as ordinary PCs. Through product supply management and raw material supply management, the inventory status of partners can be identified, and the efficiency of shortening the delivery period can be achied through efficient production management.

○ As an enhancement project, two on-site PCs are added to control the automation equipment added to the reaming machine and oven machine, which is a follow-up process. manufacturing supply MES S/W is installed on the PCs to execute process management and reduce defect rate and increase production volume by automating manual work.

○ Product supply MES S/W is developed as an application program that access to the database server with the development language C# environment.

○ The e-SCM is developed on the web and can be used through computer equipment with web browsers installed.

○ In the application server, the MES application, which collects counter information of each facility from the NS Logger and transmits it to the cloud database server, and e-SCM web application are operating, while the cloud database server stores and manages data from MES applications and e-SCM.

4. Conclusion

The AI Smart Factory Model for integrated production management in this paper is built on the basis of the smart factory establishment, advancement, and easy maintenance system dissemination and expansion project promoted by the Ministry of SMEs and Startups to enhance the competitiveness of SMEs manufacturing sites; firstly to improve production process of industry 4.0 SMEs manufacturing sites based on the spread of smart factories and synchronization of expansion projects of Ministry of SMEs and Startups; secondly to secure the ease of upgrading the manufacturing technology of homogeneous SMEs by spreading the smart factory model of promising leading companies; thirdly to maximize the effectiveness of support for government-funded projects, and to execute objective diagnosis of manufacturing level, and to share guidelines for the enhancement; fourthly to expand operational efficiency and digital transformation of SMEs manufacturing sites; fifthly to expect to contribute to bridging the gap between large and small businesses in automated production system. The AI Smart Factory Model for integrated management of packaging container production process in this paper is planned to be proposed as a government support project for SMEs.

References

[1] Heejoung Hwang, "Design of Remote Management System for Smart Factory," International Journal of Internet, Broadcasting and Communication(IJIBC), Vol. 12, No. 4, pp. 109-121, 2020.
DOI : http://dx.doi.org/10.7236/IJIBC.2020.12.4.109

[2] Jinle Liang and Minjung Kang, "Design of Remote Management System for Smart Factory," International Journal of Internet, Broadcasting and Communication(IJIBC), Vol. 13, No. 1, pp. 20-25, 2021.
DOI : http://dx.doi.org/10.7236/IJIBC.2021.13.1.20

[3] Sunjin Yu, A Study on the Training Program Strategy for Activating Smart Factory of Local Small and Midsize Manufacture, Master. Thesis. Department of Smart Manufacturing Graduate School of Industrial Technology & Management Korea Polytechnic University, KOREA, 2020.
[4] https://www.smart-factory.kr/smartFactoryIntro
[5] Chigon Kim, Jongyouel Park and Deawoo Park, " Implementation of Real-time Integrated Platform for Producing Food Packaging Container," International Journal of Internet, Broadcasting and Communication(IJIBC), Vol. 13, No. 1, pp. 194-200, 2021.
DOI : http://dx.doi.org/10.7236/IJIBC.2021.13.1.194
[6] Minzheong Song, "A Case Study on Energy focused Smart City, London of the UK: Based on the Framework of 'Business Model Innovation'," International Journal of Advanced Smart Convergence (IJASC), Vol. 9, No. 2, pp. 8-19, 2020.
DOI : http://dx.doi.org/10.7236/IJASC.2020.9.2.8
[7] Yoonsu Jeong, "A Model Design for Enhancing the Efficiency of Smart Factory for Small and Medium-Sized Businesses Based on Artificial Intelligence," Journal of Convergence for Information Technology, Vol. 9, No. 3, pp. 16-21, 2019.
DOI : https://doi.org/10.22156/CS4SMB.2019.9.3.016