A REVIEW PAPER ABOUT THE APPLICATION OF MANUFACTURING EXECUTION SYSTEM IN DAIRY INDUSTRIES IN MALAYSIA

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ABSTRACT

The halal food industry is one of the most active emerging industries worldwide, which has recently received considerable attention from both academics and investors. Malaysia as one of the leading countries in Halal food recognized this opportunity and built up its capacity by preparing a blueprint and subsiding the Halal firm's development and sustainability. However, besides external competition and customers behavior change, this Halal food industry generally and dairy particularly is still facing major internal challenges including the problems of low level of production management information, inadequate and incomplete information transmission, disconnection between management and production, lagging production command, etc. Manufacturing Executive System (MES) has been recognized as a crucial tool that helps eliminate human error in manufacturing by providing real-time quality data checks, yield monitoring, automatic enforcement of specifications and business rules. Yet, the implication of MES in the food industry in many developing countries including Malaysia still in the infant stage. Therefore, this review paper aims to review the importance of MES in the diary industry and how it can be used to bridge the current challenges.

Keywords: MES, Manufacturing Execution System, Food, Dairy, Industry, Malaysia

INTRODUCTION

The halal food industry in Malaysia is booming in recent years. Consumer demand for food has also changed considerably. Alongside the national aim to make Malaysia the world halal hub (Mohd Nawawi et al., 2019) the industry is gaining its popularity day by day and opens up opportunities to halal food producers to expand their target market domestically and internationally. Though the halal concept relates the Muslim society in specific (Haleem, Khan, Khan & Jami, 2020), there is a huge potential to tap the non-Muslim community interests when it comes to food. *Halal* is an Arabic word meaning lawful or permitted. In reference to food, it is the dietary standard, as prescribed in the Qur'an (the Muslim scripture). The opposite of halal is haram, which means unlawful or prohibited. Halal and haram are universal terms that apply to all facets of life. In general, every food is considered halal in Islam unless it is especially prohibited by the Qur'an or the Hadith (Azam & Abdullah, 2020). By official definition, halal foods are those that are:

1. Free from any component that Muslims are prohibited from consuming according to Islamic law (Shariah) (Oktadiana, Pearce & Chon, 2016).
2. Processed, made, produced, manufactured, and/or stored using utensils, equipment, and/or machinery that have been cleansed according to Islamic law(Al-Hammadi, Al-Shami, Al-Hammadi & Rashid, 2019).

Dry dairy is one of the Halal food types that has recently received considerable attention from Malaysian policymakers. This industry witnessed rapid growth, especially in the past decades. However, the halal food industry, especially dairy, is facing multiple challenges in both internal capabilities and external market competition, which affects its market share and profitability. According toAnnual International Trade Statistics by Country HS02, (2021), the value of exports of commodity group 0402 "Dairy and cream, concentrated or containing added sugar or other sweetening matter from Malaysia totaled $ 231 million in 2020. Sales of commodity group 0402 from Malaysia decreased by 8.21% in value terms compared to 2019 and exports of commodity group 0402 "Dairy and cream, concentrated or containing added sugar or other sweetening matter decreased by $ 20 million (cumulative exports of commodity group 0402 from Malaysia amounted $252 million in 2019) (Annual International Trade Statistics by Country (HS02), 2021).

In recent years, in Malaysia, the state has been more and more strict in the supervision of food manufacturers general and for halal food manufacturers in particular, for dairy products manufacturing industry, many mandatory national standards and rules have been introduced successively, and clear requirements have been put forward for enterprises to establish a tracking and tracing system for products. In addition, with the rapid development of online sales and overseas agent purchases, industry competition is also increasing. Therefore, in order to survive and maintain profit growth, dairy enterprises must improve their internal skills and continuously improve their management level.

As an important bridge and link for enterprise production process control and management information integration (MES). MES system can realize the control of the whole manufacturing process, ensure the consistency of production plans in each shop. It also enables operators and managers to know the progress of the implementation of the plan, products in process, quality, and other information on time. In addition, MES facilitates the retrospective analysis of materials batch, production time, equipment, personnel, inspection results, and other information for each batch of products. This helps to reduce production costs, increase production efficiency, and save labor costs. Consequently, it helps to meet the requirements of the new version of QS GMP for establishing a total quality management system and tracing the whole process of products. Despite, the importance of MES in the improvement of firms' capabilities, the implementation of MES in Malaysian Halal food firms generally and Halal dairy firms particularly is still not well recognized. Therefore, this paper aims to highlight the importance of MES in the Dairy industry and arrived with a set of recommendations.

MES in Dairy Industries

The dairy sector is now accessible on an advanced platform that is equipped with technology, significant investment, and high-tech equipment due to rapid developments. These technical and inventive advancements in the sector have enabled dairy enterprises all over the world to meet rising customer needs in a variety of ways (Ali et al., 2019).

Selection of MES

MES selection has an important impact on the success or failure of the project. Therefore, in the process of MES selection, it is necessary to know who you are, to understand the functional requirements of the enterprise itself for the MES system, and to conduct detailed analysis and adequate research on it, and then to select software products that can meet the needs.

At present, the MES industry is still in its initial stage of development in many developing countries including Malaysia as a whole, mainly focusing on well-known foreign manufacturers, such as Rockwell, GE, HP in the United States, Siemens in Germany, Schneider, etc. Their products have

the advantages of a mature system, comprehensive functions, modular configuration, and support for secondary development. Enterprises can choose the best choice according to their conditions and needs (Aziz et al., 2019).

MES Function Range

MES can be generally understood as a comprehensive production management system. It plays a connecting role in enterprise information integration and is a bridge for information communication between production activities and management activities. It is also true that enterprises will have a variety of expectations and imagination about MES before it comes online (Kletti et al., 2015). Therefore, when choosing functions, enterprises must go through detailed argumentation and research, combine their development stages and investment budget, and not blindly pursue large and complete, but gradually implement and perfect with fewer but more refined stages. In general, dairy enterprises can select and implement early MES projects according to the following functional modules.

Data Acquisition and System Integration

MES system can complete real-time collection of various data in the workshop automatically or manually through various forms, such as industrial flat panel, PDA, Android mobile phone, RFID equipment, bar code gun, etc., (Menezes, Creado & Zhong, 2018). It provides support for information transfer, review and confirmation, process monitoring, and various report generation in the production process. The information collected usually includes process parameters, personnel operation data, production process record data, quality data of raw materials and accessories package, equipment operation data, in-process delivery data, production completion data, etc., (Rozs & Ando, 2020). The MES system needs to be integrated with the enterprise's ERP system to achieve information such as production plan, formula BOM, finished quantity, material consumption of docked ERP (Rozs & Ando, 2020). It needs to be integrated with WMS system to achieve automatic receiving and receiving management (Chen & Voigt, 2020). It is necessary to integrate with the automation system and automation equipment of the production shop to guide, track and control the production process, ensure accurate material delivery, accurate process parameters, detailed recording of production process information, fast and accurate tracing (Rozs & Ando, 2020).

Work Order Management

The dairy industry is a fast-moving consumer goods industry. Plans fluctuate greatly with the market(Rantlo, Tsoako & Muroyiwa, 2020). APS systems (Advanced Planning Scheduling) which start online at the beginning often do not achieve the expected results, so it is recommended that enterprises maintain the management of orders with ERP system in the early stage (Wang, Chen, Liu & Chu, 2021). In general, the MES system obtains monthly plans from the ERP system and then breaks them into day plans or team plans according to needs. MES keeps track of the status of the work order during the execution of the work order and collects related material information, equipment information, process information, operation information, etc. to form an association with the work order. After the end of production, the MES system returns the collected material consumption data and output data to the ERP system, forming a complete project, which facilitates the cost accounting of the ERP system.

Formulation Management

If an enterprise has formula management in the ERP system, it can directly invoke the formula by the interface. If not, it is necessary to set up the formula management module in the MES system. MES requires privilege management and version management of the formula. In the production process, the formula can be used as the basis for materials to be weighed, fed and mixed, to ensure the correct and accurate use of materials (Mantravadi & Møller, 2019).

Process Management

1- Material distribution management. The MES system generates the material requirement plan according to the production order, combines the BOM table with the result of production progress monitoring, and splits it up (Kletti et al., 2015). It is sent to the WMS system in batches for warehouse personnel to check and execute, so as to ensure the accurate and timely delivery of materials to the production site.
2- Material bar code management. MES system establishes bar code assignment rules for all materials. For the circulation and use of materials in every production link after they enter the production shop, barcode scanning is used to check and confirm the material information, ensuring the accuracy and traceability of material use (Chen & Voigt, 2020).
3- Batch weighing. For dairy production enterprises, the ingredient process is important, most of the materials are weighed manually, so the probability of error is relatively high (Feil et al., 2020).

Enterprise online MES system, the first consideration is to establish a complete set of ingredients weighing system, which contains:

(1) There is either a direct invocation of formulas from ERP or a self-built set of formulas management modules.
(2) Equipped with a high-precision electronic scale with a communication port to obtain the weighing values automatically.
(3) Establish a material bar code identification system. All materials are scanned to determine identity information such as name, batch number, supplier, quantity, and status. Use bar codes to mark and manage materials, so as to achieve accurate weighing and material error prevention.
(4) Establish the principle of preferential use of short-term materials and spare materials, and automatically match to the corresponding scale according to the type of materials and the accuracy of the scale. Set up the checking and calibration mechanism of the scale, prompt the ingredients personnel to send the scale for inspection, and calibrate the scale regularly.

Through these measures, standardization, and accuracy of the ingredient process can be guaranteed.

4- Fault-proof feeding. MES uses a bar code scanning function to establish a material review mechanism. By comparing with BOM information of materials, MES ensures the accuracy of materials in delivery, including item, batch number, validity period, weight, etc. so as to achieve the purpose of material error prevention and product quality assurance.

Inventory Management

The inventory management function of the ERP system only goes to the shop floor level, it cannot record and track the material used on the shop floor in real-time and in detail. Therefore, it is very important to set up a set of online inventory management systems with perfect functions by MES.

The management scope of MES includes temporary raw and supplementary materials, packages, intermediate products, manufactured goods, auxiliary products, finished products, etc. in each section of the workshop. Virtual sublibraries with different names are designed according to the material category or storage area. The materials are received, received, and returned through the combination of bar code scanning and manual input, and the status of materials inventory in the workshop is displayed in real-time. And has the functions of material validity management, low

inventory warning, FIFO, etc. Finally, through the connection with the ERP system, the material consumption data in the production process is returned to the ERP system in real-time after the end of production.

Inventory management requires a complete query function and report display, the real-time query of inventory, consumption tables, inventory tables, and support authorized users to manually adjust inventory.

Quality Management

MES system can control the quality of the production process, including quality release, process sampling, sample management, tracking, and tracing.

By docking with ERP, obtain quality inspection information of raw materials, and control the production shop to get only qualified materials; And after the materials are brought into the shop, track and record the effectiveness of the materials. At the same time, the intermediate products in the production process can also be incorporated into the MES system for management, including sampling, label coding, quality inspection results feedback, release, etc. The MES system can collect production process quality data online by automatic acquisition or manual entry to provide data support for SPC analysis.

Device Management

MES system obtains real-time data such as on-site status, running speed, downtime, the number of defective products, etc., of the equipment by connecting with the device's PLC or installing sensors. With these data, the production line can be monitored in real-time, the problems of the equipment can be warned and notified quickly, the downtime of the equipment and the maintenance cost of the equipment can be reduced, the production time can be shortened, the generation of undesirable products can be reduced, the production efficiency can be improved, and the production cost can be reduced.

Electronic Batch Recording

With the increasingly stringent requirements of national laws and regulations on dairy products enterprises, the electronic batch record has become an inevitable trend in the future. After the enterprise comes online with the MES system, it can design a complete set of electronic production batch record systems by collecting relevant information in the production process in various forms and summarizing this information according to the requirements of laws and regulations, combined with the actual needs of the enterprise. Electronic batch record saves labor costs, improves job efficiency, ensures the authenticity, integrity, and timeliness of data, and facilitates data analysis and process tracing by managers.

Electronic Kanban

Electronic Kanban can transfer production information quickly and accurately, such as production plan information, material requirements information, work order progress information, product information, equipment status information, inventory status information, etc. It can make the production process more transparent and intuitive, the connection between various processes more smoothly, reduce waiting time, and improve production efficiency.

Reporting Functions

Reporting is essential for a complete MES system's systems need to provide a rich range of report statistics, analysis, and query functions, including various types of production reports, in a variety of forms, as far as possible with charts, such as column charts, pie charts, line charts, Gantt charts, waterfall charts, classification summary tables, and support output and printing to meet various management needs, provide management improvement and decision support for managers.

CONCLUSION

The application of the MES system in the dairy industry is still in its infancy. From the actual application effect, it can improve the whole production management greatly, which can be reflected in the following aspects:

(1) Through the construction of MES, the timeliness and accuracy of production plan directives and production process information transmission are improved, and production efficiency is improved.
(2) Through the model design of the MES system flowing, the flowing and standardized operation specification is established.
(3) Through the establishment of a weighing system and material balance, the fine management of materials is achieved, the risk of misuse of materials is reduced, and the cost of material consumption is saved.
(4) Through real-time collection and processing of production process data by MES, the information and transparent management of the production process is realized. By setting up an electronic batch record of production, the authenticity, timeliness, and accuracy of data are guaranteed, the labor cost is saved, and the production efficiency is improved. Through the implementation of MES in production links, the important link of enterprise information connectivity has been opened, and the whole process of electronic quality tracking and tracing has been achieved.

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