Research and Application of Asynchronous Brand Switching Error Prevention Model for Cigarette Factory's Tobacco Feeding and Cigarette Making

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Abstract. Cigarette factories usually adopt asynchronous brand switching mode to switch production brands for tobacco feeding and cigarette making units. The asynchronous brand switching model, while improving production efficiency, brings the risk of brand error as well, which becomes a major quality hazard. This article aims to build a joint error prevention model for multiple systems in a cigarette factory to ensure consistent production brands after brand switching for both tobacco feeding and cigarette making machines, eliminating the risk of brand mismatch and eliminating quality hazards.

Keyword: Tobacco Feeding, Asynchronous Brand Switching, Error Prevention

1 Introduction

In recent years, cigarette manufacturing enterprises have placed higher demands on rapid flexible production in response to market demands for small batches, multiple specifications, and multiple brands of cigarette production [1]. The tobacco feeding and cigarette making units that undertake the production tasks are facing the situation of multiple brands, heavy tasks, and complex cigarette specifications. Under the condition of increasingly frequent switching of production brands, most cigarette factories use an asynchronous switching mode in which the feeding machine and cigarette making machine switch their brands respectively, in order to ensure production efficiency [2]. This means that the feed machine switches its brand immediately after production ends, and the tobacco is sent from the warehouse through the logistics system to the feed machine in advance. Once the cigarette making machine has completed its brand switching, the tobacco is immediately fed. Compared to synchronous brand change, asynchronous brand change can save at least 30 minutes of logistics pre-filling time, greatly improving brand change efficiency. But it may lead to brand mismatches between the brand of the tobacco provided by the feeding machine and the brand required by the cigarette machine, which is one of the most serious quality risks in cigarette factories [3].

Therefore, it is urgent to develop an error-prevention technology model that can be applied to asynchronous label change operations for feeding and packaging, automatically eliminating potential quality accidents in advance, or generating alerts or alarms to prevent such quality accidents from occurring in the near future [4].

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2 Existing problems

The tobacco feeding and cigarette making operations involve the collaboration of multiple systems to complete the issuance and execution of production orders, as well as the transfer of materials and information. The current process is as follows in Figure 1:

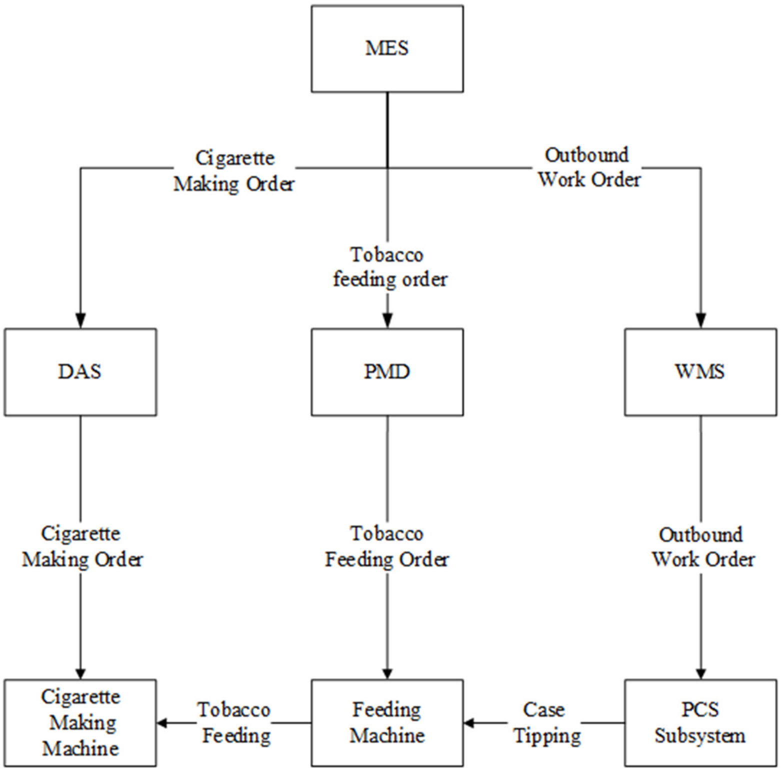

Fig. 1. Current process of tobacco feeding and cigarette making

The manufacturing execution system MES generates a cigarette making order and a tobacco feeding order.

The cigarette making order is issued to the data acquisition system DAS, and the tobacco feeding order is issued to the central control system for tobacco production and the logistics system WMS for the finished tobacco warehouse.

The control worker of tobacco production system selects the tobacco feeding order in the system and sends it to the case tipping machine control system. The control worker of WMS selects the tobacco feeding order in WMS and sends it to the PCS subsystem.

When production begins, the control worker of tobacco production system starts the tobacco feeding order of the case tipping machine, and the control worker of WMS starts the tobacco feeding order in PCS subsystem. Cases of tobacco leave the warehouse from the high-rack warehouse and is sent to the feeding unit.

The cigarette machine operator selects and starts the cigarette making order, and the tobacco is fed from the feeding unit to the cigarette making machine.

The main risks that lead to brand mismatching during the entire information interaction process are as follows:

When the order is started, there is a lack of comparison between the information of the orders on the DAS and tobacco production system.

The tobacco feeding orders of WMS and tobacco production system are manually checked.

There is no information verification between the tobacco feeding unit and the cigarette making unit during production.

3 Main research contents

This article mainly focuses on two aspects to establish an asynchronous brand switching error prevention model. On the one hand, the research of time synchronization schemes between independent systems, can ensure consistent interaction log times between systems, improve the reliability of information exchange, reduce the probability of human error in operations, and provide basic support for subsequent quality tracking. On the other hand, during the issuance of work orders, the joint collaboration of MES, tobacco production system, and DAS, can ensure the consistency of work orders for tobacco making unit, WMS, and case tipping machine in real time, improve the accuracy of tobacco feeding, and achieve the consistency verification of the information in the whole process of tobacco feeding and cigarette making production.

3.1 Network time synchronization based on NTP

This article involves a large number of systems, with complex communication interfaces and information exchange logs between various servers and PLCs. Time synchronization between these systems is critical to information exchange processes and tracing of related issues, and NTP-based network time synchronization is therefore used. NTP is a standard internet time synchronization protocol that uses a software-only approach to achieve network time synchronization with an accuracy of milliseconds [5].

By establishing a factory-level time synchronization server, various system servers and PLCs at the device level can synchronize with the factory-level time server to achieve time consistency, as shown in Figure 2.

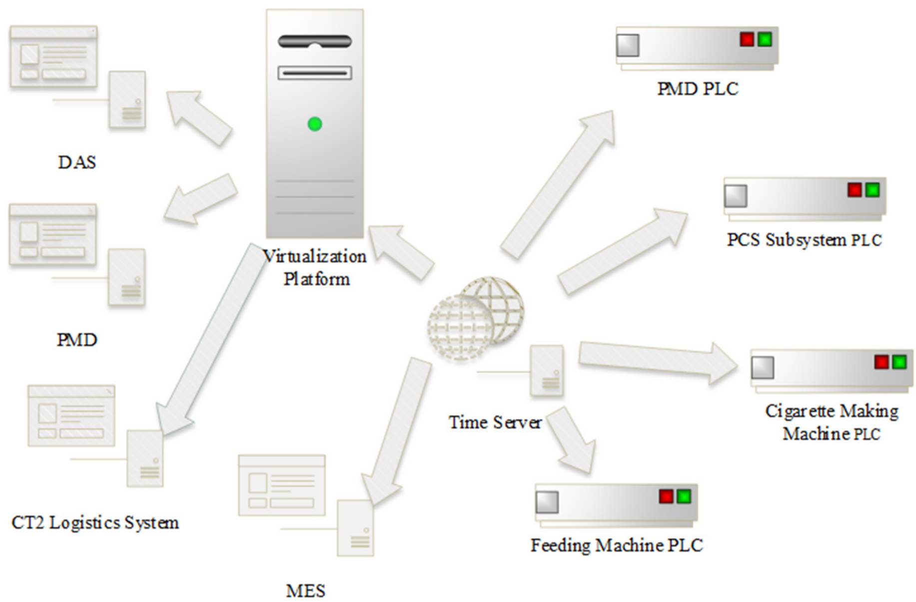

Fig. 2. Network topology of time synchronization system

3.2 Production order data consistency checking across multiple systems

According to the process of issuing orders to various systems, data verification for each system is designed to ensure consistency in information such as the tobacco batches and brands of the orders throughout the entire process. The procedure of preventing errors in the consistency of orders' data throughout the entire process is shown in Figure 3.

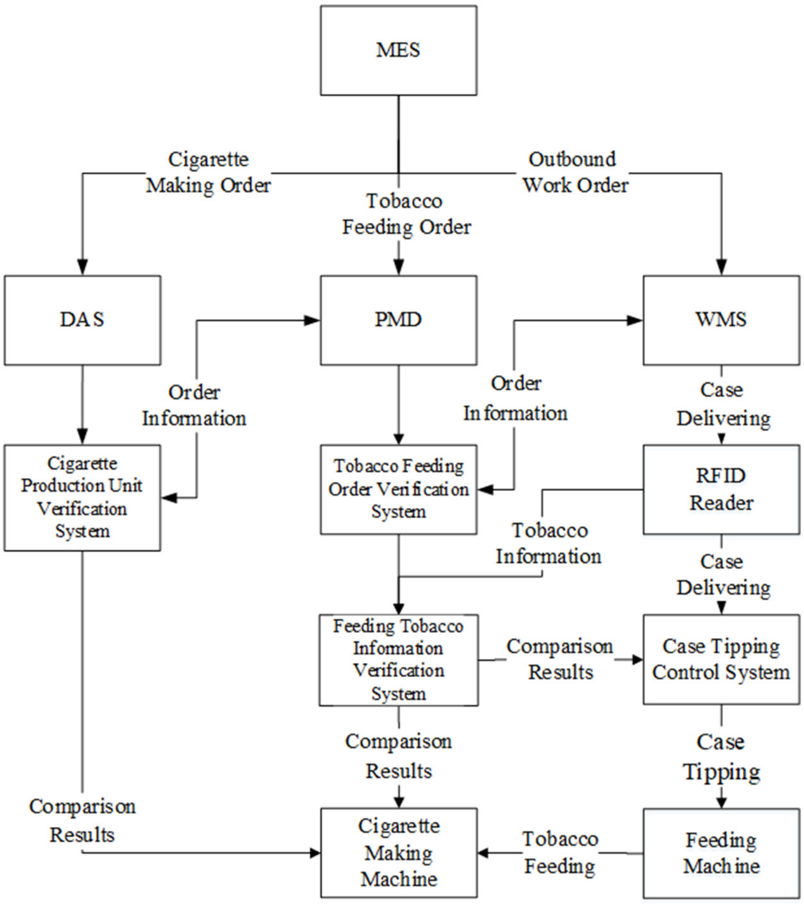

Fig. 3. The procedure of preventing errors in the consistency of orders' data of the entire process

After a tobacco feeding order is selected, PMD sends the order information to the verification system of the cigarette production unit. The verification system of the cigarette production unit compares tobacco feeding order information in the PMD with the cigarette making order information issued by DAS. If the comparison verification results are inconsistent, PMD cannot start the order. Otherwise, the cigarette production unit verification system will send the order information to the corresponding cigarette making machine and start the cigarette production order. After receiving the feedback of the comparison and verification from the cigarette production unit verification system, PMD will open the tobacco feeding order and send the work order information to the tobacco feeding order verification system.

After selecting the feeding order from WMS, the order information is sent to the tobacco feeding order verification system, which compares the outbound work order and tobacco feeding order information. If the comparison results are inconsistent, WMS cannot start the feeding order. Otherwise, WMS can start the feeding order, and the feeding order verification system will send the order information to the feeding tobacco information verification system.

After the cases of tobacco are delivered from the warehouse to the feeding station, the RFID reader reads the tobacco information from RFID cards under the tobacco boxes, and WMS sends this information to the tobacco information verification system. The tobacco information verification system compares the information with the order information from feeding order verification system, and sends the comparison results to the case tipping control system and cigarette making machines.

According to the result from tobacco information verification system, the case tipping control system will tip the cases that are consistent, and reject the cases that are inconsistent to exit station and generate alarms on the monitoring SCADA.

The cigarette making machine determines whether to start a cigarette production order based on the comparison results of the cigarette machine production unit verification system. Meanwhile, during production, once the tobacco information verification system gives inconsistent results of tobacco information comparison, the cigarette making machine will immediately suspend production.

Through consistent comparison of order details and logistics information across various systems, the probability of human error is reduced, thereby avoiding the occurrence of quality accidents caused by mislabeling.

4 Achievements

This paper focuses on tobacco feeding in the cigarette manufacturing process, aiming at the issues of insufficient information verification between multiple systems, incomplete identification of operational risks within the system, and system time synchronization. By establishing an asynchronous brand change error prevention model, the problem of tobacco brands mismatch in cigarette making and inaccurate quality tracking time are resolved.

Through the application of project results, it is possible to achieve joint error prevention capabilities in various production processes of cigarette making and tobacco feeding in cigarette factories. It has prevented several errors in the orders of tobacco feeding caused by misoperation, and no further quality incidents related to wrong brand of tobacco feeding have occurred. The risk of misbranded tobacco has been eliminated and product quality assurance capability has been enhanced.

5 Conclusion

Through the research on key technologies of intelligent error prevention models of asynchronous brand switching for tobacco feeding and cigarette making, relevant production systems have been improved and optimized. The probability of human error, waste caused by product quality accidents, and manufacturing costs have been reduced. While the efficiency of quality accident tracing has been improved and the level of lean management has been enhanced.

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