Design and Application of Quality Traceability System Based on Improved Production Process of Cigarette Packaging

Mengshi Fan, Chengkun Xu(✉), Li Chen, Jianfeng Xu, Zhaoshun Li, Zhenhan Zhang, Baocheng Hu, Bei Cao, and Wen Zou

Qujing Tianfu Tobacco Leaf Redrying Co., Ltd., Qujing 655000, Yunnan, China
31602992@qq.com

Abstract. As most of the finished tobacco products are only sprayed with two-dimensional codes and the frequency of scanning is low, it is not national unified standard, and no correlation among the pack, carton, and box of tobacco products. The study of combing two-dimensional codes and radio frequency tags helps to improve the production process of cigarette packaging and associates the traceability code with the pack, carton, and box of cigarette products. With the support of the theory of quality traceability system, it are realized, such as quality tracking, anti-counterfeiting traceability, retailer collusion monitoring, product flow research, and consumer marketing, etc. Additionally, the collection and analysis of big data prove to be useful in the application of quality traceability systems in tobacco products.

Keyword: Cigarette packaging · Quality traceability · Traceability code design

1 Introduction

With the continuous improvement of living standards in China, the government has paid more attention to the safety of the food industry [1, 2]. Quality traceability technology and system have been widely used in manufacturing, logistics, and sales in developed countries [3–5]. Similarly, by the active efforts of relevant departments, we has also achieved good results in the application of quality traceability [5, 6], especially high-end liquor, organic vegetables, ecological meat, crop seeds, and other high value-added products [7, 8].

At present, two-dimensional codes have been printed on the outer packages of most tobacco products, but due to the limited scope of action and single function, there is no correlation of two-dimensional codes among a pack, carton, and box of the products [9, 10]. As a result, the significance of the study is to promote the effective application research of the traceability code of tobacco products in production organization, logistics, consumption, quality traceability, anti-counterfeiting traceability, consumer marketing, early warning of collusion, inventory monitoring and among others.

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Table 1. Comparison of types and characteristics of RFID tags

Types	Characteristics
Passive tags	(1) No pow supply. (2) Transmission of data is driven by electromagnetic waves. (3) Low price, small volume and wide application.
Semi-passive tags	(1) Small battery inside. (2) Power supply is used for return signal. (3) Higher efficiency than passive tags.
Active tags	(1) Power supply inside. (2) They can drive the tag IC. (3) Longer transmission distance and a larger amount of information storage.

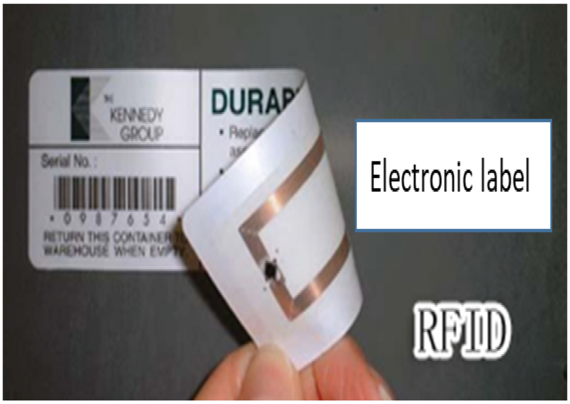

Fig. 1. Passive RFID tags

2 Traceability Code Optimization of Tobacco Products

2.1 Analysis of Traceability Code Labels

There are four forms of commodity traceability codes in the market: Radio frequency identification tags (RFID Tags),bar codes and spraying auxiliary codes, two-dimensional codes, and NFC tags.The last two tags have sprung up and developed rapidly.The NFC tag is one of the radio frequency electronic tags, and its application development speed is also very fast, because most smart phones are integrated with NFC function. According to energy supply, the RFID Tags can be divided into passive tags, semi-passive tags, and active tags as shown in Table 1.

According to the practicality, functionality, and cost of cigarette packaging, the passive tag of RFID are selected in this study, as shown in Fig. 1.

2.2 Optimization of Traceability Code Scheme

According to the above analysis of the status quo, an innovative idea is proposed in this paper. Combining the advantages of two-dimensional codes and RFID tags to create a traceability code carrier of tobacco products. In the same tag, the code information loaded by two-dimensional codes and RFID tags is corresponding and consistent.

The specific scheme is to put the two-dimensional code and RFID tag in the outer package of a small pack, a carton, and a box of cigarettes.The combination of the two-dimensional codes and RFID tags means that the two-dimensional code is printed or sprayed on one side of the outer side of the RFID tag to form a combination of two tags (two-dimensional tags for short).

The combination of the two-dimensional code and RFID tag is selected as the carrier of the traceability codes of tobacco products, which is a better technical scheme considering the existing environment and technology.

3 Design of Traceability Code for Tobacco Products

The traceability system design of tobacco products does not only mean product quality traceability but also includes all relevant information data that can be traced and used, such as logistics information, allocation regional information, sorting, transshipment of tobacco products, and distribution information of commercial companies, receipt confirmation of retailers and in-store inventory information.

3.1 Overall Design

The overall design scheme for the implementation of the traceability system for tobacco products is shown in Fig. 2.

It can be seen from Fig. 2 that the tobacco industry, logistics, enterprises, retailers, and consumers can be connected in series to form a complete data chain through the traceability code of tobacco products, which associates the two-dimensional barcode labels on packs, cartons, and pieces (box).

3.2 Design of Associating a Pack and Carton of Tobacco Products

This paper proposes two solutions to the association mode of a pack and carton: a standard version and a simplified version.

The standard version scheme is shown in Fig. 3. A special RFID reader is erected above or on the side of the conveying guide rail of the packaging machine for the finished cartons of tobacco products to read the RFID tag information in the two-dimensional barcode tags of the cigarette passing through the rail, and then it is transmitted and stored in the special database to complete the matching association between the trademark of one carton and the traceability code of 10 small packs.If the read information is abnormal, the products will be automatically kicked out and checked manually.After manual checking, they will be put into the conveying guide rail again to read the matching information again.

The simplified version is that the existing two-dimensional barcode printing is only adopted in the packaging of a small pack, as shown in Fig. 4. The association of two-dimensional barcodes between a pack and a carton of cigarettes will be realized by packaging small packs of cigarettes in cartons by the packaging machine.The small

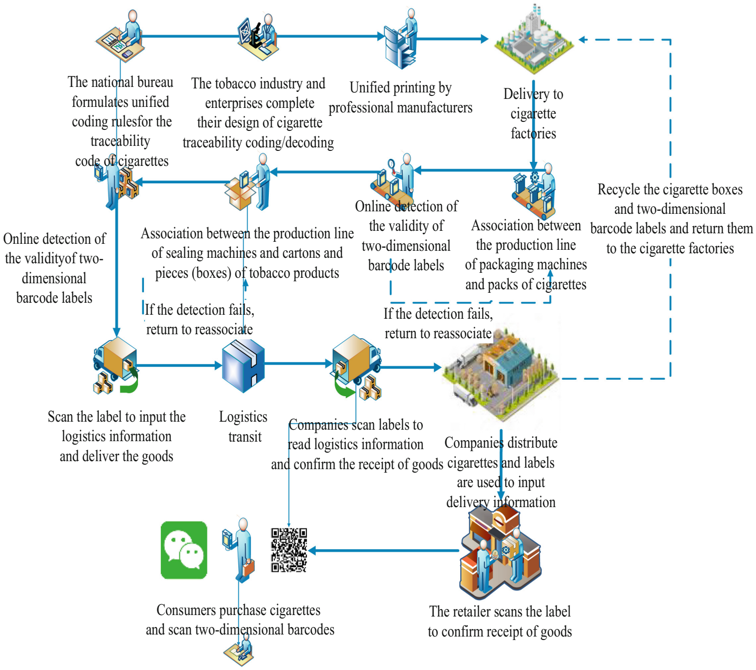

Fig. 2. Diagram of Traceability Code System for Tobacco Products

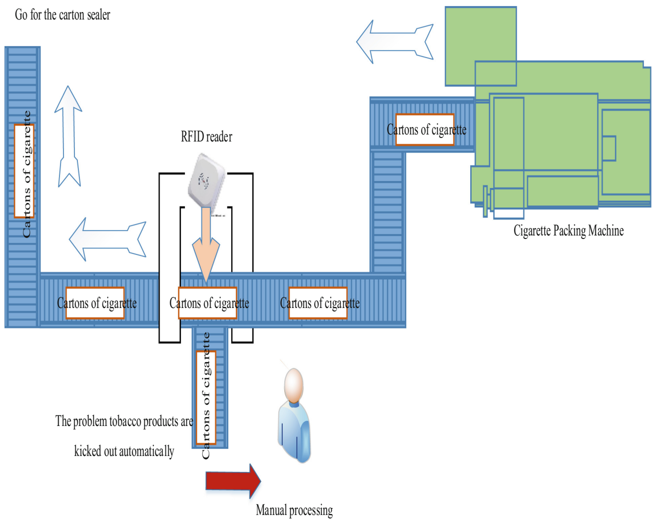

Fig. 3. Schematic diagrams of the standard version

packs are arranged in two lines which include 10 packs and brought into the packaging machine, and the two-dimensional barcode of the small packs can be uniformly set at the

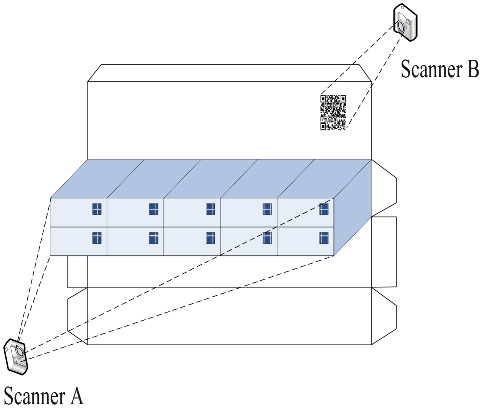

Fig. 4. Schematic diagrams of the simplified version

head or tail of the package.Before a group of ten small packs is put into the packaging machine, one scanner scans and records the two-dimensional barcodes of the group of 10 packs of cigarettes at the same time, and the other scanner scans the two-dimensional codes of the carton including ten packs of cigarettes and uploads the scanning results to the relevant database to associate the codes on packs and cartons.

The advantage of the simplified version lies in the no use of RFID tags, which lowers the cost in Table 2. The disadvantage is the difficulty in transforming the existing production equipment and packaging process, and the higher requirements of adding equipment.Additionally,once the equipment fails in the packaging process or can not identify the two-dimensional codes because of the quality, it has to be matched again, which may cause a high frequency of shutdown of the packaging machine, and poor production continuity and stability.The standard version aims to solve the shortcomings of the simplified one.Even if there is something wrong with some of the two-dimensional barcode labels in a carton of cigarettes, it will not affect the work of the packaging machine nd assembly line. For a simplified version, if a carton of tobacco products is packaged, it is difficult to check the two-dimensional barcodes of its small packs inside (unless the package of the carton is opened to scan and detect the barcodes of the small packs inside). As for the standard version, it is very convenient to check merely by just reading the package of a carton once again through a dedicated RFID reader to inspect the matching with the internal packs.In addition, the speed of the RFID tags sensing data through the radio magnetic wave is much higher than that of the camera scanning and identifying the two-dimensional codes, and the RFID tags enjoy more advantages in medium and high-speed packaging machines.

3.3 Design of Associating a Carton and Box of Tobacco Products

According to the design of associating a carton and box, the two-dimensional barcode label on the outer package of a box of cigarettes can be pasted/hung at a designated position outside the cigarette box in advance and then packaged, or pasted/hung at a

Table 2. Comparison between the two versions

	Standard Version	Simplified Version
With RFID tags or not	Yes	No
Cost	Higher	Lower
Difficulty of transformation	More difficult	Less difficult
Stability	Higher	Lower
Convenience of recheck	More convenient	More cumbersome
Read speed	Faster	Slower

designated position outside the cigarette box after being packaged; finally, the two-dimensional barcode label is conveyed to a station provided with a special RFID reader by a conveying roller machine to read all information of the two-dimensional barcode labels in the cigarette.The data of two-dimensional barcode labels of the small packs are removed from the collected data, and after the two-dimensional barcode labels of a box of cigarette is associated and matched with that of 50 cartons of cigarettes, they are stored in the industrial production cloud database together with other relevant data, as shown in Fig. 5.

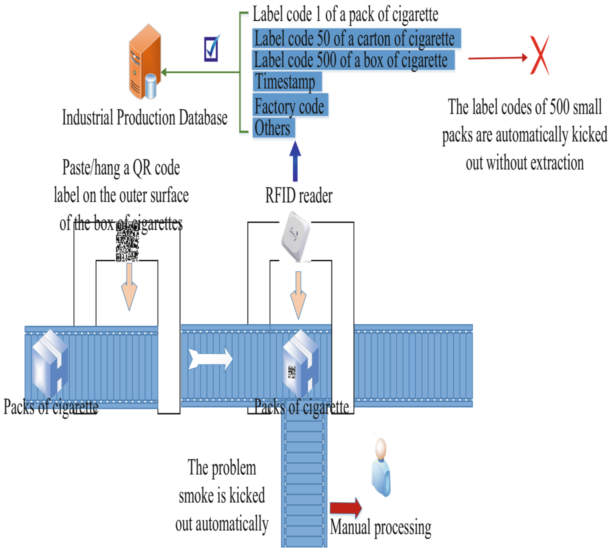

Fig. 5. Schematic Diagram of associating a carton and box

3.4 Overall Structure

After the associated design of the pack, carton, and box, the overall architecture diagram of the traceability code system of cigarette products is drawn on this basis, as shown in Fig. 6.

Each link and unit in the whole cigarette industry chain are connected in series through traceability codes, corresponding databases are gradually established through the collection of data from different objects, and finally, the data are collected and stored in the data center of the National Bureau.According to the needs of different objects, the National Bureau can open the corresponding data downlink authority for large data sharing, so as to facilitate the enterprises to develop their applications.

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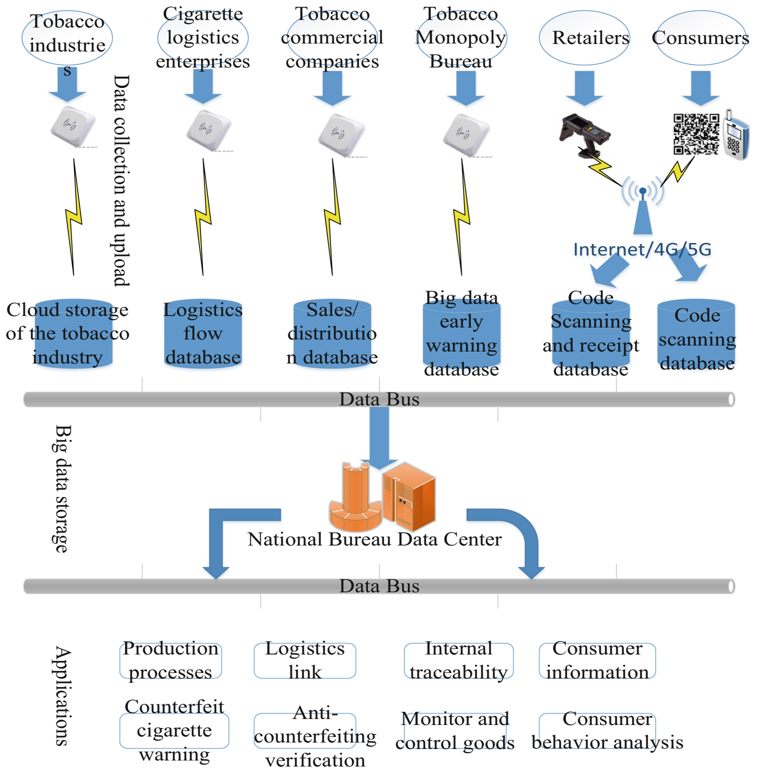

Fig. 6. Architecture of Traceability Code System of Tobacco Products

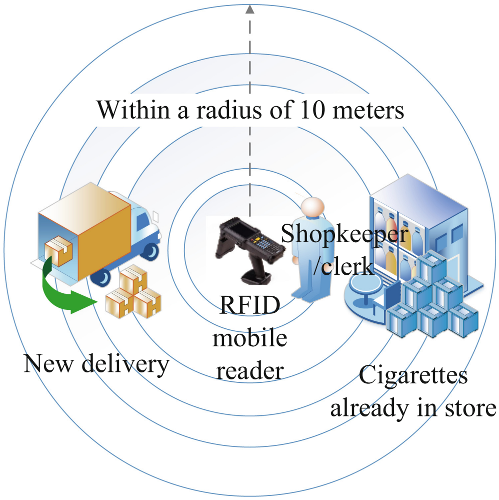

Fig. 7. Schematic Diagram of Application Principle of Traceability Codes in Retail Terminals

4 Application of Traceability Codes of Tobacco Products

4.1 Cigarette Retailers

When the cigarette retailer receives the cigarette products delivered by the local tobacco companies, the mobile/portable special RFID reader is used to scan the delivered new products, and the system automatically summarizes the cigarette list and compares it with the order of the retailer, and displays the comparison result to the retailer, as shown in Fig. 7.

4.2 Production of the Tobacco Industry

In the production of the tobacco industry, internal quality traceability can be realized quickly and accurately by loading the information on the whole process of cigarette production, as shown in Fig. 8.

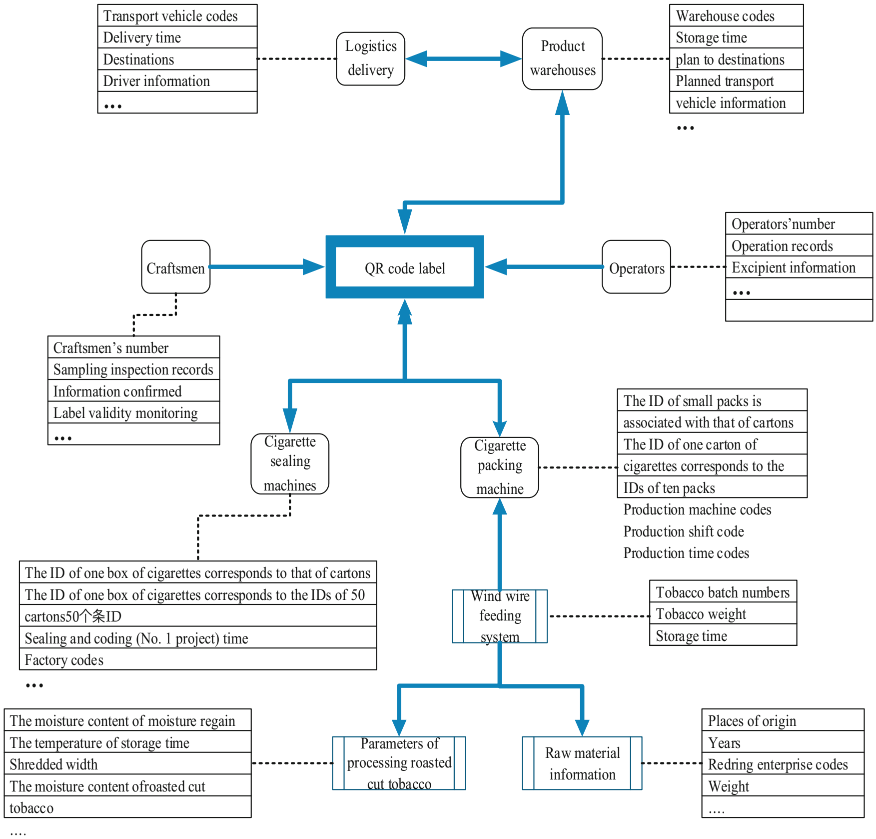

Fig. 8. Application Model of the Production of Tobacco Industry

5 Conclusion

5.1 Innovations

The innovations of this paper are to realize the association of a pack, carton, and box through the innovative design of traceability codes, and to expand the new functions such as early warning of retailers' collusion, social inventory monitoring, consumption data mining, and so on.Through a small traceability code of a tobacco product, the traditional one-way supply chain mode of industrial enterprise-commercial enterprise-retail customer-consumer can be transformed into an interactive supply chain of consumer-industrial enterprise-commercial enterprise-retail customer-consumer.It is important to effectively promote the digital transformation and upgrading of the cigarette industry, build an industrial system with big data of the whole production and marketing chain as the core driving factor, and provide strong support for high-quality development.

5.2 Difficulties in the Construction of the Traceability Code System for Cigarette Products

The construction of the traceability code system for cigarette products almost involves the entire production and marketing chain of the tobacco industry.A tobacco enterprise can first carry out trial production on units of some production plants and then summarize and analyze the follow-up construction based on results and experience.The key and difficult points in the construction of the traceability system for cigarette products are summarized as follows.

(1) Embedded printing technology and process standard of two-dimensional barcodes + RFID tag in the cigarette trademark.
(2) The high efficiency and stability of the association mode among packs, cartons, and boxes in the production process.
(3) Construction of new retail terminals.
(4) The transformation of the concept and mode of big data mining and analysis.

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