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# Study on Supply Chain Information Control Tower System

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**Abstract:** Due to globalization and price fluctuation, the bullwhip effect is serious in the supply chain. An important issue in supply chain management is the real-time information visibility. Thus an innovative concept of "supply chain information control tower" is proposed. Firstly, five layers to analyze the system are established. The logistics information is collected from the business data relying on Internet of Things technology. The information data are analyzed in the information platform layer. Based on data mining decisions are made in the manpower layer. In the second phase, the control principle of the tower is given. The double-loop feedback control model can reflect the elements of information control and locate the steps with quality problems accurately. Finally the background data processing of the control tower is studied. The RIA method and Web Service technology is the core of tower control processing. The supply chain quality control tower has provided theoretical support for information control and traceability.

**Key words:** Supply chain, information control tower, double-loop feedback control

## INTRODUCTION

The supply chain is a set of organizations linked by upstream and downstream flows of products, services and information. Nowadays Supply chain visibility is the key enabler for managing a business within the organizational boundaries.

With the continuous promotion of the concept of supply chain management, the companies have begun to introduce and apply supply chain management mode to maintain the sustainable competitiveness. In developed countries, the industry has adopted supply chain management to improve the operation of the entire supply chain efficiency and benefits. The supply chain links include procurement, production, processing, packaging, distribution, retail, after-sales service and so on.

Therefore a new concept of "Supply Chain Information Control Tower" is proposed. The control tower can provide theoretical support for the total supply chain quality control and retrospective issues. Section 2 describes the supply chain control literature research. Section 3 discusses the structure of supply chain information control tower system. Section 4 studies the background data processing of supply chain control tower. Section 5concludes the study.

## LITERATURE RESEARCH

The information is the characterization of the scientific and technological level of a country and the foundation of a business survival. So information control is the eternal theme of enterprises and the soul of business management. As the supply chain information is very completive and uncertain, the research into it has been a hot topic. After further study we have concluded that the research on the supply chain quality control focus on three aspects:

- Studying the concept and structure of supply chain quality control, such as Feigenbaum (1991) proposed the concept of "total quality control" Feigenbaum (1991) and Tang (2004) indicated that quality control was quite important in manufacturing industry nowadays. The supply chain quality control tower of FMCG is proposed (Ji *et al*., 2013)
- Further study on the collaborative control technology of product quality, such as Forker *et al*. (1997), Liu *et al*. (2006) and Musheng *et al*. (2008)
- Research on the reliability study of supply chain, such as Guo *et al*. (2006) and Xin *et al*.(2008)

After entering the 1990s, the supply chain has been the most popular topic in academia and industry. However, the study of quality management throughout the supply chain has been not too much. Under the impact of the traditional production business model enterprise quality management has focused more on the company's internal quality but less on external environment (Chen *et al*. 2000; Helo, 2000). They have been blocked by series of "quality barriers" among

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suppliers, manufacturers, distributors and end users. Under the production mode of the increasingly significant globalization, the pursuit of rapid response and the personalized service, the "Barriers" type quality control has been unable to meet the requirements of the whole life cycle (Robinson and Malhotra, 2005). In china the collaborative supply chain quality control has just begun. Many companies have been lack of synergy awareness of most enterprises in the supply chain management process. Therefore we need to study the collaborative operation of the supply chain information further (Liu *et al*., 2006).

## STRUCTURE OF THE CONTROL TOWER SYSTEM

Firstly we have to clear the product information process in supply chain.

Based on the theory of the total supply chain quality management, we have proposed the system of the control tower in this study. The supply chain information control tower system can be represented with "five layers". The basic structure of the control tower is as shown in Fig. 1. Next we have explained the five layers in detail from bottom to top.

**Supply chain business layer:** This layer is in the bottom located in the base of control tower. It's the basis of the entire supply chain. It includes supply chain members and major aspects of supply chain business. This layer mainly characterizes supply chain business forms and mass transfer law.

The supply chain members include raw material suppliers, manufacturers, outsourcing logistics service providers, distributors, dealers and users.

The major aspects of the supply chain business include procurement, transportation, warehousing, loading and unloading, handling, distribution processing and packaging, distribution and information services.

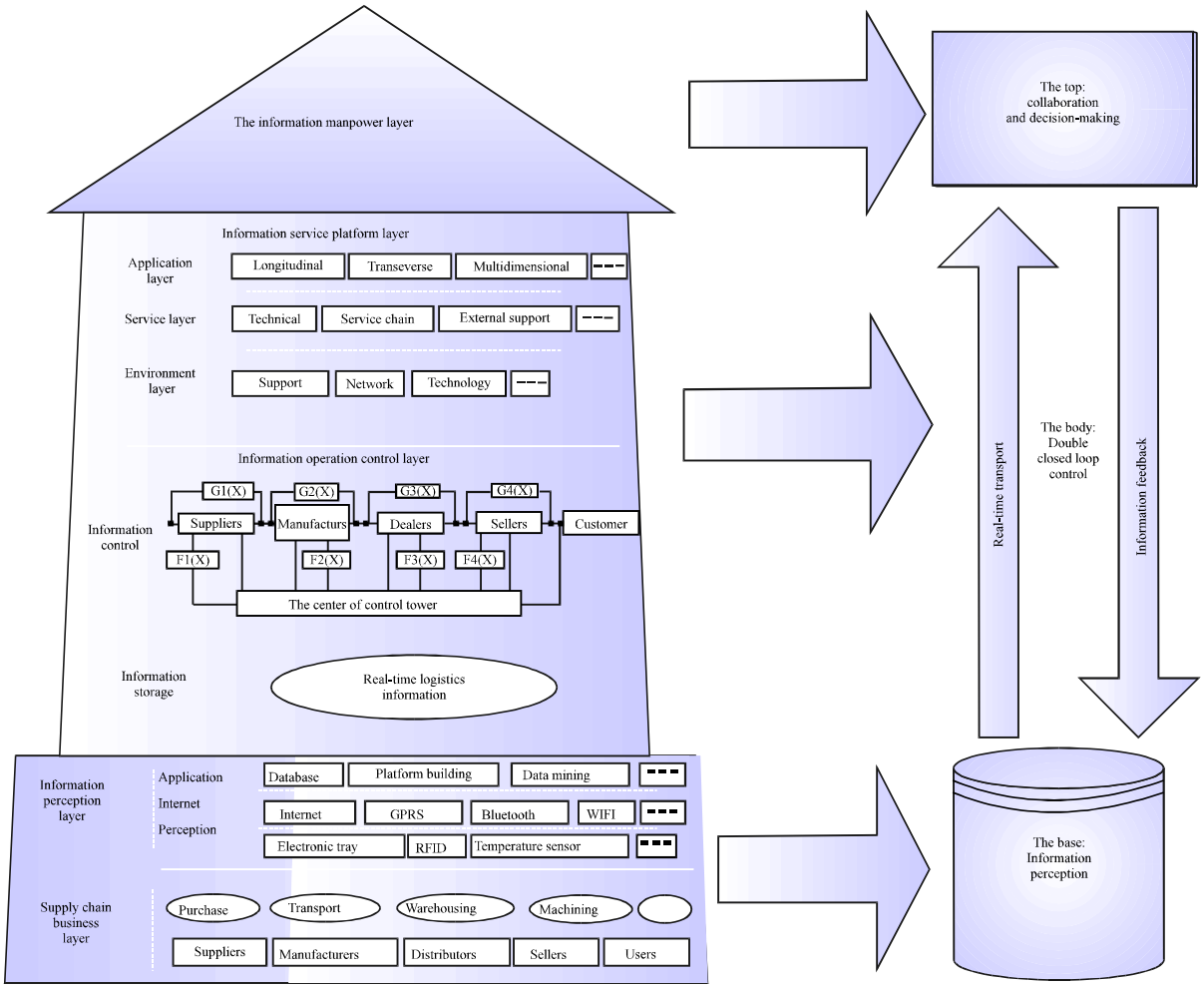


Fig. 1: Supply chain information control tower system

**Information perception layer:** It's the upper part of the layer located in the base of the tower and "perception nerve" of supply chain quality. This layer is use of Internet of Things technology to achieve real-time sensing and transmission of supply chain quality. The Internet of Things technology is the integration of information collection and transmission means including RFID, barcode technology, GPS, Video technology, temperature sensor, humidity sensor, chromatographs, GPRS, Blue Tooth, WIFI and other transmission technology (Tajima, 2007).

The backscatter RFID System is the main tool to collect information in the control tower.

The operation of the typical passive backscatter RFID system includes an RFID reader and a passive RFID tag, shown as Fig. 2. The passive tag consists of an antenna and an application specific integrated circuit chip, both with complex impedance. The chip obtains data and power from the Radio Frequency (RF) signal transmitted by the RFID reader. The tag sends data back by switching its input impedance between two states (Zc1 and Zc2) and thus modulating the backscattered signal. The tag presents a certain Radar Cross-Section (RCS) at each impedance state. One of the impedance states is generally high (RCS1) and the other is low (RCS2) to provide a significant difference in the backscattered signal.

With power and frequency the variation of the chip impedance can drastically affect the performance of the tag. In this way, proper impedance match between the chip and antenna is very important in passive RFID systems. It directly influences RFID system performance characteristics such as the reading ability. In usual, in order to maximize the reading ability, the antenna impedance is matched to the chip impedance at the minimum power level required for the chip to work.

Data exchange between tag and reader can employ various modulation and coding schemes. The signal transmitted on the uplink contains both Continuous Wave (CW) and modulated commands as shown in Fig. 2. On the tag to the reader, the data is sent back during one of CW periods when the tag impedance modulates the backscattered signal. The passive backscatter RFID system can be produced at a favorable price, but the read ability is strongly limited by the overall efficiency of the system. The antenna characteristics have a radical effect on the read ability of RFID systems.

**Information operation control layer:** It's the lower layer located in the tower body. It includes two parts: the supply chain information storage part and the supply chain information control part. The storage part can provide total information for the control part. In turn the control parts can feedback the results of information control to the storage part. Thus the two parts together have achieved the core control function of the control tower.

The information derives from the Internet of Things perception layer in the base of tower. The information includes all sectors of the real-time quality information of supply chain: Procurement, transportation, storage, loading and unloading distribution processing, packaging quality, distribution and so on. It is just like an information pool to make all information collected together. Moreover it can also store the feedback control information.

The next part is just like the heart of the tower. It's the most important part in the control tower. The supply chain quality double-loop feedback control, the main control principle, is divided into two levels; the first level is oriented to the whole business and the other faces to the internal operating procedures. Next we have described the two levels in detail.

The first level--the business-oriented quality feedback control logic model: Along the supply chain forward process, the model can control the product quality of every operator of the subject. The final product deviation is fed back to the individual operating companies in the supply chain. Then the model can form the whole chain feedback control. The detailed are as shown in Fig. 3.

In Fig. 3 the dotted arrow shows the quality of information transfer while the solid line arrow represents the feedback control function. And $F_i(X)$, (i = 1, 2,..., 6) Represents the feedback information control function of

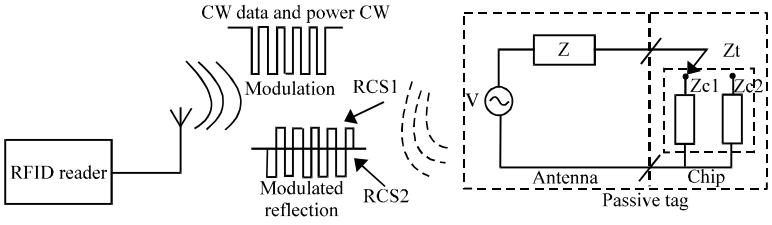


Fig. 2: Passive backscatter RFID system

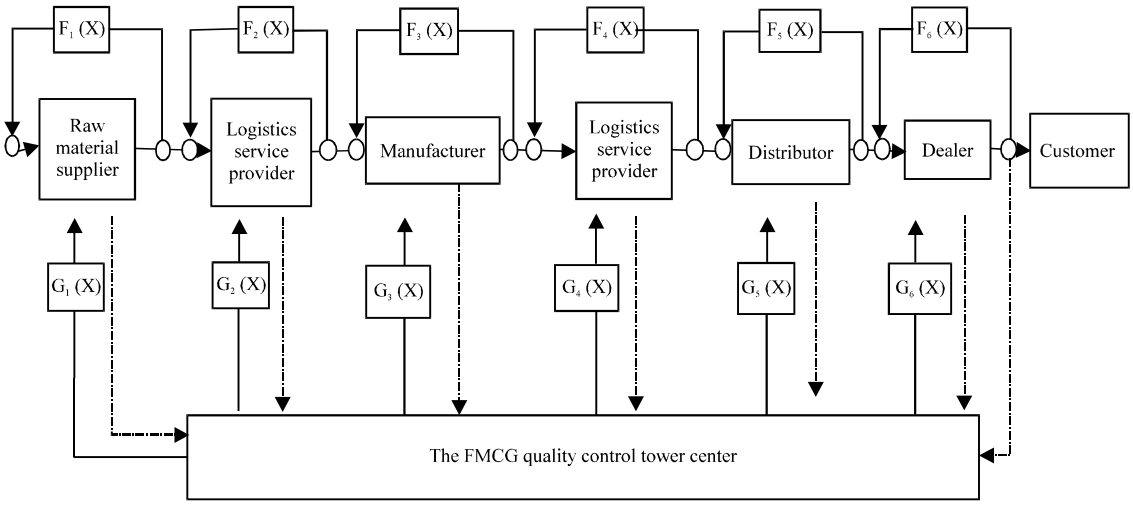


Fig. 3: Business-oriented information feedback control logic model

the i-th subject in the supply chain. The function is the main information control house. $G_i(X)$, (i = 1, 2,..., 6) Represents the collaborative feedback information control function of the i-th subject in the supply chain. The function is the main control status signals of this subject.

The second level--the quality feedback control logic model oriented to internal operation steps: Along the supply chain forward process inside an enterprise, the model can control the product quality of every operator of the subject inside the enterprise. The final product quality deviation is fed back to the individual operating steps in the supply chain. Then the model can form the whole chain feedback control.

The dotted arrow shows the quality of information transfer while the solid line arrow represents the feedback control function.

And $H_i(X)$, (i = 1, 2,..., 5) Represents the feedback quality control function of the i-thstepof the FMCG manufacturers. The function is the main quality control house of this step. $G_i(X)$, (i = 1, 2,..., 5) represents the collaborative feedback quality control function of theith business step of the FMCG manufacturers. The function is the main control status signals of this business step.

In the two models, the feedback information control functions are the information control house. We have studied the function as follows. We have established the information control indicators system of various components through the analysis of the information process. Relying on the information database of the control tower the quality house can find the corresponding weak links. The quality house is originated from the Quality Function Development (QFD). It can achieve real-time control of the main supply chain quality. The main part of the quality control house includes some information dimensions: the quality demand indicators, the quality influencing factors and the weight of affecting factors.

To ensure the quality of the supply chain, it is very important to eliminate quality problems in the bud. So the quality control of raw materials is the top concern of the supply chain. Through the establishment of quality control house of procurement aspects, we can find quality defects in a timely manner and correct them.

**Information service platform layer:** It's the upper layer located in the tower body. It's the integrated quality information service platform faced to all links and subjects of the supply chain. Firstly, it can store centrally and update the quality information from the lower layer dynamically so as to implement the transparency and visualization of quality information. Secondly, it can be real-time monitoring of the supply chain full information. Moreover, the third function of the platform is to achieve retrospective of the whole supply chain quality issues and feedback control.

**Information manpower layer:** This layer is in the top of control tower. It's the supply chain manpower control center and the decision-making center. It is responsible for the centralized monitoring in every link of the supply chain of product quality. This layer has masked overall running information control, early warning and decision-making of supply chain in a macro way.

This layer is integrated "information hubs" that provide the whole supply chain visibility. These hubs are used for gathering and distributing information and allow people trained to use these visibility capabilities to detect and act on risks or opportunities more quickly. This enables three levels of management control:

- Strategic-provides control over the design of the overall supply chain network
- Tactical-enables proactive planning of procurement, operations and distribution according to market demand
- Operational-encompasses various real time functionality including transportation management, inventory tracking and exception management

## THEBACKGROUND DATA PROCESSING OF CONTROL TOWER

The background data processing is studied for the technical support of control tower (Fig. 4). The specific processes are following.

**Message processing logic:** It includes message communication components to achieve permission authentication and data exchange services for subjects of supply chain. It includes Email message communication components; SMS massage communication components and MQ messaging communication components.

**Data filtering logic:** After storing business data the post-judgment module access to relevant information database. The information of action, state, business is stored according to types of business. Then the ro object is resolute in the data analysis logical thread pool.

**Data parsing logic:** It is primarily responsible for pure data processing and analyzing deeply. To exception handling, for example, the logic receives the ro data from the filtering process and gets the abnormal formula and the parameter values in the formula. If the results show the need for traceability and recall issues, then it can enter the traceability and recall dual-threaded processing logic module.

**Information control logic**

**Information control single-thread logic:** The analytical results are obtained from data processing logic. Then it calls the function of information control and stores the control results into the database record. The loop can be dynamically controlled to achieve an acceptable information deviation range.

**Traceability dual-threaded logic:** The results are received from the data processing logic thread pool. And it calls traceability and tracking function. It will not only trace the problems to the source of supply chain, but also recall the product and store the results into the traceability database. Then improvements are measured depending on the specific situation.

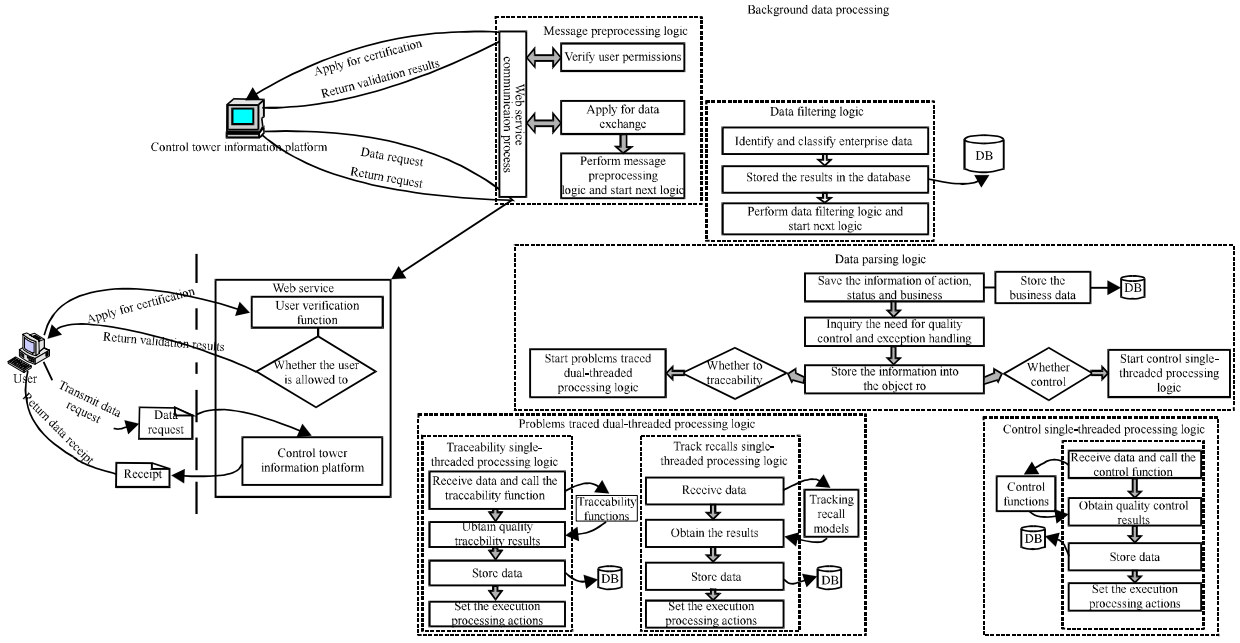


Fig. 4: Background data processing of information control tower

## CONCLUSION

Based on the theories presented in this study, a new way to control the supply chain quality has been proposed. For the research on the characteristics and supply chain quality control, this study has made a deep discussion on the supply chain quality control tower. The main research findings are as follows:

- This study has created a new theoretical model "supply chain quality control tower" combined with the actual characteristics of the supply chain
- The control tower has used "five layers" architecture to control and trace the problems of the whole chain of quality
- This study has focused on discussing the double-loop control model of the control tower. Moreover the quality control house has been the function of the model

The supply chain quality control has been a breakthrough and innovation in the supply chain management theory and methods. It has provided a new method to control the whole supply chain quality. The further research on the system of the supply chain quality control tower has been still under way.

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## REFERENCES

Chen, F., Z. Drezner, J.K. Ryan and D. Simchi-Levi, 2000. Quantifying the bullwhip effect in a simple supply chain: The impact of forecasting, lead times and information. Manage. Sci., 46: 436-443.

Feigenbaum, A.V., 1991. Total Quality Control. 3rd Edn., McGraw Hill, New York, ISBN: 0070203547, Pages: 863.

Forker, L.B., D. Mendez and J.C. Hershauer, 1997. Total quality management in the supply chain: What is its impact on performance. Int. J. Product. Res., 35: 1681-1702.

Guo, X.S., L.Y. Sun and S. Xu, 2006. Study on a kind of reliability model on multi-echelon supply chain based on SCPN. Operat. Res. Manage. Sci., Vol., 6.

Helo, P.T., 2000. Dynamic modelling of surge effect and capacity limitation in supply chains. Int. J. Product. Res., 38: 4521-4533.

Ji, S.W., Y. Tian, Z.H. Zhang and H.L. Lu, 2013. Research on the FMCG supply chain quality control tower system and operation mechanism. Adv. Mater. Res., 694-697: 3610-3613.

Liu, X.M., W.M. Cheng and J. Liang, 2006. How to apply quality function deployment in supply chain. J. Logist. Technol., 9: 63-65.

Musheng, Y., Z. Yu and N. Jiarui, 2008. Product quality collaborative control technology in SCM. Proceedings of the IEEE International Conference on Automation and Logistics, September 1-3, 2008, Qingdao, China, pp: 180-185.

Robinson, C.J. and M.K. Malhotra, 2005. Defining the concept of supply chain quality management and its relevance to academic and industrial practice. J. Product. Econ., 96: 315-337.

Tajima, M., 2007. Strategic value of RFID in supply chain management. J. Purchasing Supply Manage., 13: 261-273.

Tang, X.Q., 2004. The quality control under modern manufacture pattern. Science Press, Beijing.

Xin, Y.H., A.H. Zheng and W.W. Hu, 2008. The well-posedness analysis of the reliability model for the supply chain. Math. Pract. Theory, 1: 46-52.