Design of reverse logistics system for B2C e-commerce based on management logic of internet of things

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Abstract: In recent years, the B2C e-commerce industry has developed at a surprising high speed in China, but the return rate of e-commerce is also increasing at the same speed, which makes the demand of reverse logistics of B2C e-commerce difficult to meet under the traditional logistics mode. To solve this problem, based on the logic of internet of things management, this paper designs and constructs the collaboration system and information interaction system of reverse logistics in B2C e-commerce, builds the basic framework of reverse logistics system in B2C e-commerce, and discusses the possible system bugs. The reverse logistics system designed in this paper will be more suitable for the local government-led business cooperation platform organisations. It can create a regional B2C e-commerce reverse logistics consortium for local governments, and even play a positive role in promoting the rapid development of the entire B2C e-commerce industry.

Keywords: B2C e-commerce; reverse logistics system framework; internet of things; collaborative system design; information interaction system design.

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1 Introduction

Since 2015, the Chinese Government has proposed the development strategy of ‘innovation and entrepreneurship’ with the core of ‘internet +’ (internet +, refers to the new development of internet development under the ‘Innovation 2.0’, and the evolution of the internet form promoted by the ‘Innovation 2.0’ in that knowledge society and the new form of economic and social development that has been spawned.) It has made the B2C e-commerce industry which has been developing at a high speed ushered in the policy catalysis at the national level, and obtained the ‘leap’ forward. Nationwide e-commerce volume has reached 29.16 billion RMB by 2017, which increased by 30 times compared with its volume 3 billion RMB in 2008 (Lin et al., 2015; Li, 2016; Wu and Zhao, 2017; Gao, 2017). However, in the face of such a high-speed development of B2C business model, consumers and e-commerce enterprises are not in fact ready for the necessary cognitive preparation and behaviour habits (Sun et al., 2017). Among them, the most direct evidence is that the product return rate of B2C e-commerce activities has manifested its rising tendency. According to the research report, the refund rate of e-commerce is growing at an average annual rate of 15%, which means that there are approximate one third of the goods sold needs returns and exchanges at different levels (Krapp et al., 2013; Tibben-Lembke and Rogers, 2002; Xu and Fan, 2009). As a result, the demand for reverse logistics generated by the return of goods is becoming more and more vigorous (Bouzon et al., 2018; Li et al., 2016; Lee and Dong, 2009). However, China’s current B2C IOT system is based on the pattern of e-commerce + traditional logistics, while e-commerce takes ‘internet +’ (as explained in the above) as its core (Liu et al., 2018; Ramos et al., 2014). This model makes the development maturity of China’s B2C e-commerce reverse logistics far behind the development of forward logistics (Govindan et al., 2015). This also makes the current IoT operation efficiency unable to show due to the ‘short board effect’. At present, the most urgent task to build an efficient B2C e-commerce internet of things system is to quickly fill the technical shortcomings of the current Chinese B2C e-commerce internet of things system, that is, the optimisation of reverse logistics system.

‘Forward logistics’ is defined as forward logistics based on the logical sequence of B2C e-commerce activities. When consumers are not satisfied with the goods and return occurs, the goods flow from consumers to e-commerce is defined as ‘reverse logistics’. At present, the research results of B2C e-commerce reverse logistics in academic world are significantly less than the research on the forward logistics problem of e-commerce (Guo et al., 2017). This is because the main work of B2C e-commerce reverse logistics system is caused by the return demand after consumer online shopping (Abdulrahman et al., 2014). Compared with the traditional forward logistics, the difficulty of reverse logistics operations is mainly reflected in two aspects. First, the demand for reverse logistics is extremely unpredictable. The time, place, quantity and destination of goods return are almost randomly distributed, which makes it impossible for the reverse logistics system to reserve the corresponding logistics distribution capacity in advance (Cardoso et al., 2013; Pishvaee et al., 2010; Sangwan, 2017). Traditional logistics companies are unable to bear the reverse logistics business of B2C e-commerce because they cannot predict the demand for reverse logistics, which makes the B2C e-commerce industry encounter technical bottlenecks. Either it is to manage a sufficient amount of logistics distribution capacity according to experience management, which causes some of the distribution resources to be idle and causes the traditional logistics company to fall into the state of inefficient operation (Metta and Badurdeen, 2013). Second, the consumption habits of consumers are difficult to integrate with the reverse logistics mode provided by traditional logistics companies (Clottey et al., 2012). The logistics services modes adopted by traditional logistics companies, which is no distinction between forward logistics and reverse logistics. 'That same mode' refers to that the place where the logistics company accepts the commodity logistics entrustment is the business network of the logistics company. Compared with traditional forward logistics system, consumers can wait and receive goods at home without leaving home (Ozdemir-Akyıldırım O et al., 2014). But in the reverse logistics system, consumers have to send goods back to the business outlets of logistics enterprises, which make the return cost of consumers higher and affect their shopping mood (Senthil et al., 2012). Therefore, the current research on B2C e-commerce reverse logistics has fallen into a dilemma between 'logistics resource operation efficiency' and 'reverse logistics must meet consumer demand'. This article is willing to continue to try in this field, hoping to put forward a substantial solution to this dilemma.

In view of the crux of the previous academic research, this paper will try to build a reverse logistics system of B2C e-commerce with the help of internet of things technology, radio frequency identification (RFID) and other technologies. This paper argues that the key to building a comprehensive reverse logistics system with the cooperation of diversified business entities lies in the design of two pillar systems: one is the 'B2C e-commerce reverse logistics cooperation system' with the participation of diversified business entities. The system will deal with the interest boundary of many diversified business entities and avoid the situation of 'market failure' caused by unclear interest boundary in the process of cooperation, which will lead to the situation that the whole B2C e-commerce reverse logistics system cannot operate normally. The second is 'information interaction system of B2C e-commerce reverse logistics', only when the information interaction between reverse logistics demand and distribution supply becomes more accurate and sensitive, can the efficiency of logistics resource allocation of multi-operators be improved, and the efficient operation of the whole B2C e-commerce reverse logistics system be guaranteed. Based on this design idea, this paper attempts to design and construct the basic framework of B2C e-commerce reverse logistics system by means of internet of things technology, which can solve the efficiency problem by B2C e-commerce reverse logistics and settle the matter of consumer demand by information interaction system. It is hoped that this will solve the problem that the reverse logistics demand brought by the rapid development of B2C e-commerce industry is difficult to meet.

In order to better achieve the expected research goals, this paper designs the B2C e-commerce reverse logistics collaboration system and information interaction system in Section 2 to build the basic framework of B2C e-commerce reverse logistics system. Then, in Section 3 of the article, the system bugs that may appear in the designed system will be discussed to ensure that the system designed in the article can play a role smoothly. Finally, Section 4 is a summary of the work done in the full text, and illustrates the research contents that this paper cannot cover, so as to expand the space for future research.

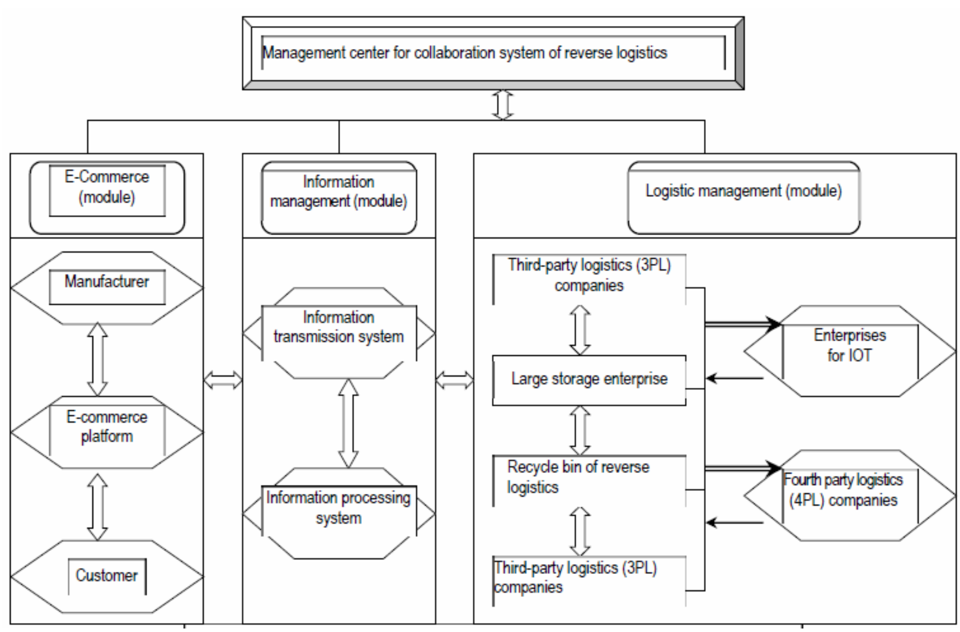
2 System design

2.1 Design of B2C e-commerce reverse logistics collaboration system

All participants in B2C e-commerce activities should be members of its reverse logistics collaboration system, while the members are selected based on the logic of B2C e-commerce activities. When selecting the members of B2C e-commerce reverse logistics cooperation system, the standard is the business logic of B2C e-commerce activities. The behavioural agent related to B2C e-commerce business will be selected as members of the cooperation system, and the people or operators unrelated to B2C e-commerce business will not be selected. All participants in the B2C e-commerce activities include: product producers, online sellers, consumers, third-party logistics enterprises, fourth-party logistics enterprises, internet of things companies, large warehousing enterprises, etc. (Govindan et al., 2016). If these participants only rely on market mechanism to operate independently, they will inevitably lead to system paralysis or inefficiency. Therefore, this paper takes the normal operation of B2C e-commerce reverse logistics system as the premise and is based on the business logic of this system, with all participants to achieve resource allocation efficiency as the goal of the collaboration system for the joint operation of all participants to design. After the design, the operation logic of B2C e-commerce reverse logistics collaboration system is shown in Figure 1. The B2C e-commerce reverse logistics collaboration system consists of three parts: e-commerce module, information management module and logistics management module. Among them, the e-commerce module is mainly composed of manufacturers, e-commerce and consumers, and they bear the traditional e-commerce business. The information management module is mainly composed of an independent information transmission system and an information processing system. It undertakes the information interaction between the forward and reverse logistics information in the e-commerce activities between the e-commerce module and the logistics management module. The logistics management module consists of a large warehousing enterprise, a reverse logistics recycling station, a third-party logistics enterprise, a fourth-party logistics enterprise, and an internet of things company. The module is a system collection of logistics resources optimisation management with the fourth-party logistics enterprise as the core and the internet of things company as the technology support. This composition is based on the business logic of reverse logistics cooperation system operation in e-commerce activities. The reverse logistics operation is initiated by the return demand of consumers, which belongs to the information management module. The process of reverse logistics activity is the logistics management module, and the end of reverse logistics activity is the completion of goods return, which belongs to e-commerce module. In the whole process of this activity, there will be no other participants involved, so the ‘reverse logistics cooperation system’ only consists of the above three parts.

The collaborative logic of the B2C e-commerce reverse logistics collaboration system at the module level is: the information management module is the bridge between the e-commerce module and the logistics management module. It simultaneously collects processes and interacts with the other two modules. It is the ‘information nerve centre’ of the entire B2C e-commerce reverse logistics collaboration system. It puts forward the work requirements to the entire B2C e-commerce reverse logistics cooperation system, and then the reverse logistics cooperation system management centre aims to coordinate the logistics resources of the three modules with the goal of system efficiency optimisation. The interaction between the three modules and the interaction between those modules and the reverse logistics collaboration system management centre are loose contractual relationships based on the 'positive externalisation internalisation' theory. Under such a loose contractual relationship, logistics resources are resource-based based on the internal market mechanism of the system, and each business entity has a clear interest boundary. Their specific way of cooperation is that the real-time data of forward and reverse logistics needs generated by the e-commerce module will be quickly and accurately delivered to the information management module. The information management module opens and classifies the demand information according to the criteria of region, speed, price, etc., and then opens the logistics management module. At the same time, the logistics management module will dynamically transfer the information of logistics supply capacity to the information management module. The information management module will open the e-commerce module after collecting and classifying the information according to the regional, speed and price standards. After the information interaction of the three modules is fully and peer-to-peer, both the e-commerce module and the logistics management module can place orders with the reverse logistics collaboration system management centre. That is, the function of the reverse logistics collaboration system management centre is mainly to accept orders, information checking, credit supervision and credit breaking control.

Figure 1 Logic figure for collaboration system of reverse logistics in B2C e-commerce



The collaboration within the e-commerce module system is mainly manifested by the collaboration among multiple manufacturers, e-commerce and many consumers. The operation logic of the collaboration system within the module is shown in Figure 2. This paper is based on the behavioural logic of e-commerce activities. It is believed that e-commerce activities are initiated by the operation that the e-commerce pushes business information to manufacturers and consumers. E-commerce plays an absolutely dominant role in information screening. Therefore, 'e-commerce' is the 'operation core' of the whole e-commerce module system. E-commerce acts as a business link between consumers and producers by using of its own strong customer and producer resources. The manufacturer transmits all the commodity information to the e-commerce, then the e-commerce classifies processes and processes the commodity information, and publishes it to the consumers through the e-commerce display platform. Consumers will then complete their shopping actions according to their own consumption needs. When consumers receive real goods, they begin to compare the gap between physical goods and shopping expectations. If the gap exceeds the consumer's tolerance threshold, they will have a return demand. Consumers send the return demand to the customer system of the e-commerce and complete the return behaviour with the e-commerce. We call the logistics generated by the return process 'one-stage reverse logistics'. At this time, in order to maintain the irreplaceability of its own brand, e-commerce will set the demand information terminal of consumer reverse logistics as the e-commerce itself, and will no longer spread the demand information to the producers. Then, they analyse and classify the reasons for the return of the consumer, in order to achieve optimal management of the returned goods. For example, the reasons for consumer reverse logistics can be divided into at least quality reasons and non-quality reasons. Then, non-quality reasons can be used by e-commerce to resell to other consumers, thus converting reverse logistics into forward logistics. However, if the cause of the consumer's return is the quality of the product, then the e-commerce will initiate a 'two-stage reverse logistics' to return the defective product to the commodity manufacturer. Therefore, the internal coordination system logic of the e-commerce module is mainly composed of two paths shown in Figure 2, that is, the 'forward logistics path' and the 'reverse logistics path' of the commodity flow.

Figure 2 Operation logic of internal collaboration system in e-commerce module

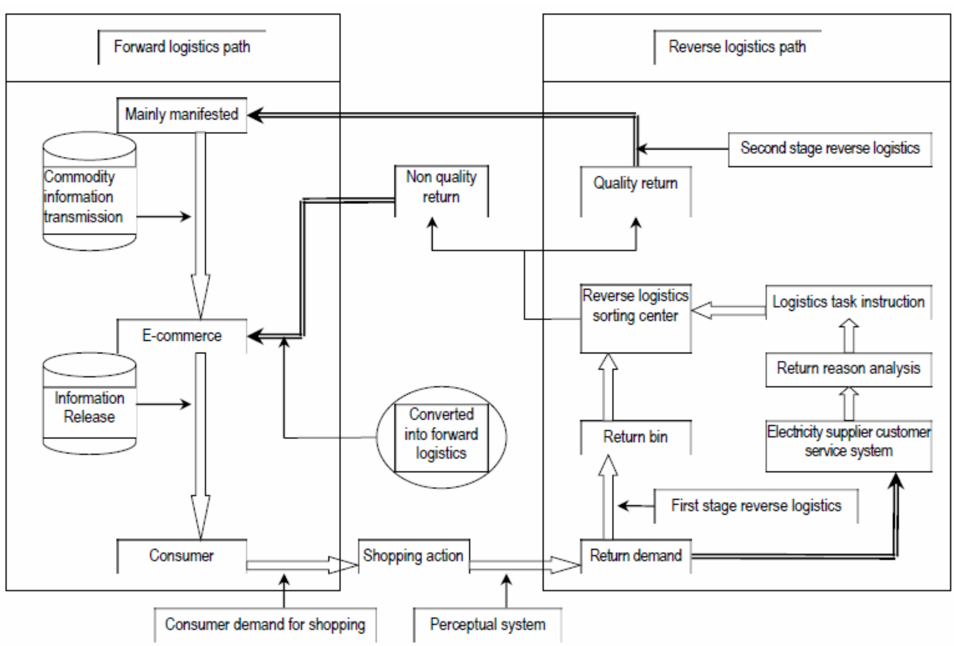
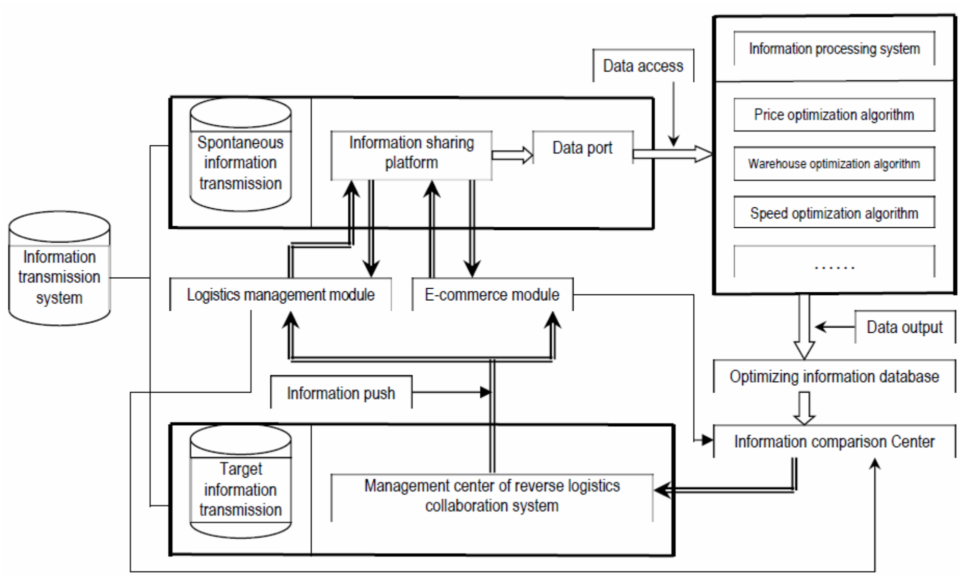
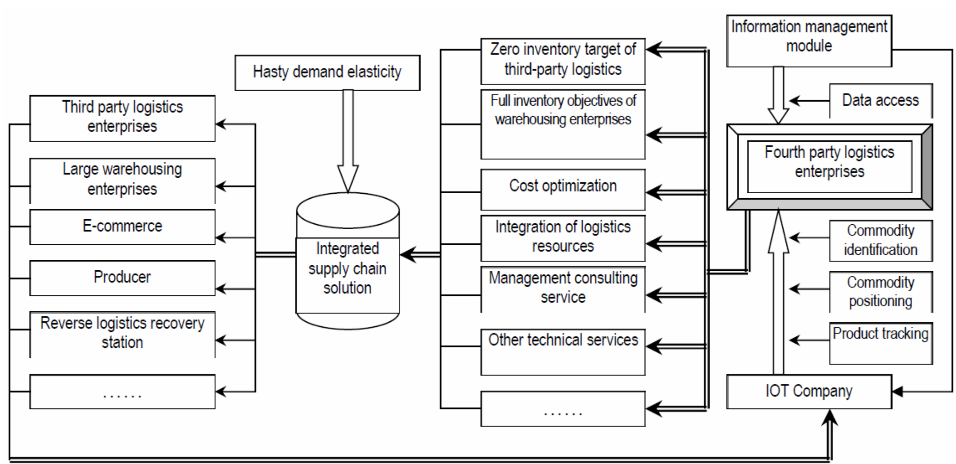


Figure 3 Operation logic of internal collaboration system in information management module



The internal collaboration of the information management module system is mainly represented by the cooperation between the information transmission system and the information processing system. The operation logic of the internal collaboration system of the module is shown in Figure 3. Among them, the main function of the information transmission system is to process the information management module with the e-commerce module, the logistics management module, and the information collection and feedback between the processing and reverse logistics cooperation system management centre. The information transmission formed by such information collection and feedback is divided into two categories: 'spontaneous information transmission' and 'target information transmission'. The 'spontaneous information transmission' method is mainly based on the information sharing platform. The information uploading, screening and searching of the e-commerce module and the logistics management module are spontaneously carried out according to their own business needs. The information sharing platform does not do any work and is in a completely passive state. 'Targeted information transmission' means that the management centre of reverse logistics collaboration system, according to the results of data processing by information processing system, purposefully and selectively pushes differentiated information to e-commerce module and logistics management module through information transmission system. The main function of the information processing system is to process the data collected by the information transmission system in-depth. It will develop many data processing algorithms according to price, speed, storage capacity and other factors. The data are optimised and calculated, and then the optimised results are sent to the reverse logistics collaboration system management centre. Finally, the results of the optimisation calculation are matched by the reverse logistics collaboration system management centre with the numerous e-commerce and logistics enterprises in the e-commerce module of the system. Then, the information transmission system is given differential information push instructions, which can greatly reduce the cost of e-commerce module and logistics management module to search for information. And enhance their efficiency in searching for information, thereby ensuring the efficient operation of the entire B2C e-commerce reverse logistics collaboration system.

Figure 4 Logistics management module internal collaboration system operation logic

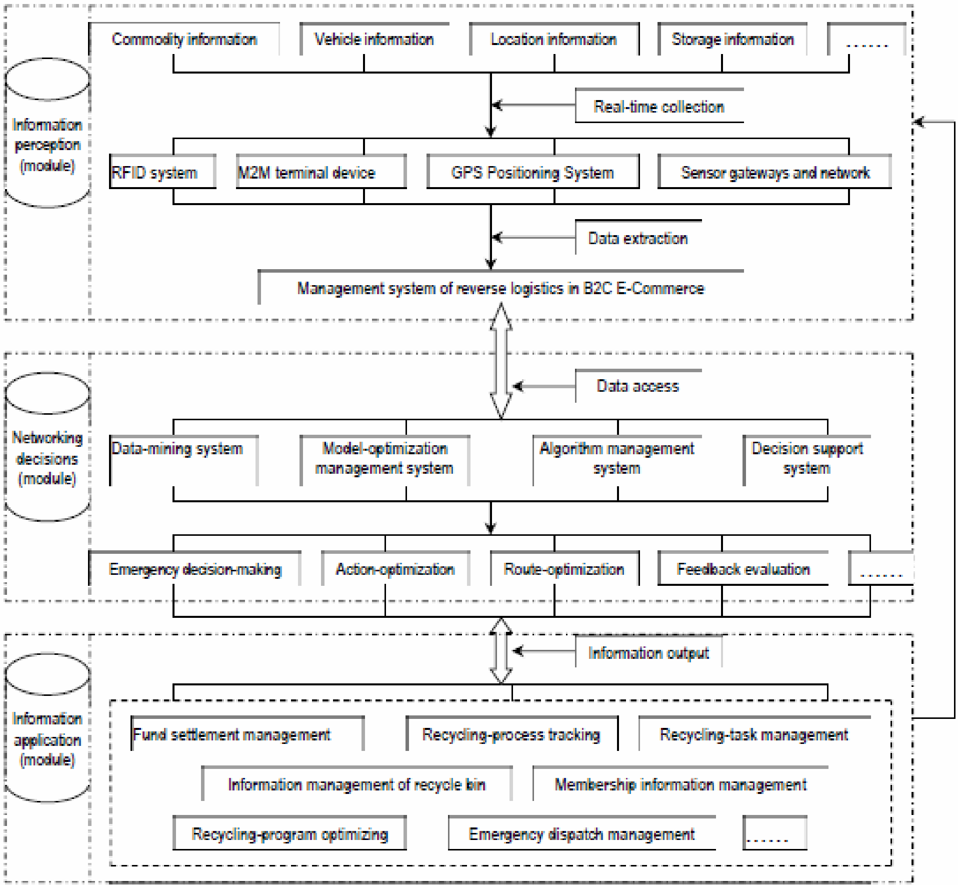


The collaboration within the logistics management module system is mainly manifested in the collaboration among the third-party logistics enterprises, fourth-party logistics enterprises, large warehousing enterprises, internet of things companies, reverse logistics recycling stations, etc. The operation logic of the internal collaboration system of the module is shown in Figure 4. Among them, as an integrator of supply chain, the fourth-party logistics enterprise relies on its strong resource integration ability to provide corresponding management consulting service, cost optimisation scheme, profit optimisation scheme and other technical services for the members of logistics system such as the third-party logistics enterprise, large warehousing enterprise, e-commerce, manufacturer and so on. By adjusting the warehousing demand elasticity of various commodities in the reverse logistics system of B2C e-commerce, the above-mentioned value-added services can be integrated into a comprehensive solution of the supply chain of reverse logistics system to meet the logistics optimisation needs of all members of the logistics system. Therefore, the fourth-party logistics enterprise is the decision-making core of the logistics management module, while the other business entities in the module are cooperating under the solution framework provided by the fourth-party logistics enterprise to realise the optimisation of the resource allocation of the logistics system. It is important to point out that according to the requirements of optimising the allocation of resources; there is a certain degree of conflict of interest between the third-party logistics enterprises and large warehousing enterprises. Third-party logistics enterprises aim at ‘zero inventory’ to achieve efficiency optimisation, while large warehousing enterprises aim at ‘full inventory’ to achieve revenue optimisation. Although there is a certain degree of confrontation between them on the surface, they are in the whole logistics management module. The actual operation of third-party logistics companies and large-scale warehousing companies is actually ‘unified’ because meeting the logistics needs of customers is the prerequisite for efficiency optimisation of logistics systems. The ‘full inventory’ target of large warehousing companies can be selectively arbitrarily based on different categories of warehousing goods. For example, under the 'full inventory' target, large warehousing companies can choose to store goods with greater warehousing demand for storage, or warehousing for goods with relatively rigid storage requirements. However, how can we ensure that goods with rigid storage requirements can be stored at a lower cost? This must rely on the IoT company to accurately identify, locate and track the goods, and enter the cargo information into the warehouse demand elasticity algorithm system. After calculation and analysis, it will be provided to the fourth-party logistics enterprise in a timely and accurate manner, and then the fourth-party logistics enterprise will carry out system analysis and optimisation. Based on the appropriate cooperation mode and benefit distribution mechanism, a comprehensive inventory adjustment plan is proposed to realise the 'unification of business objectives' and 'efficiency optimisation' between third-party logistics enterprises and large-scale warehousing enterprises.

2.2 *Design of information interaction system for B2C e-commerce reverse logistics*

The information interaction system of B2C e-commerce reverse logistics services is for the collection, analysis, optimisation and interaction of reverse logistics demand and supply information (Witkowski, 2017). Moreover, the content involved in this information is the logistics information of the goods. Therefore, the information interaction system of B2C e-commerce reverse logistics should be an information integration system based on the internet of things technology. The working principle of the internet of things is through RFID technology, infrared induction technology, positioning technology, laser scanning technology and other information sensing technology. In accordance with the information system agreement, commodities are connected to the internet, and information exchange is carried out to realise the intelligent identification, positioning, tracking, monitoring and management of commodities in e-commerce activities. According to the working principle of the internet of things, this paper believes that the reverse logistics information interaction system framework for B2C e-commerce should be divided into three parts: information perception module, network decision module and information application module. Among them, the information sensing module includes RFID system, M2M terminal equipment, sensor gateway and network, GPS positioning system and so on. Its main function is to complete the perception, identification and positioning of recycled goods and vehicles in the operation of reverse logistics system. Information perception module completes the real-time collection of all kinds of information in the process of reverse logistics operation, and transmits the collected information to the network decision-making module in real-time. The network decision module is mainly composed of data mining system, reverse logistics optimisation model management system, reverse logistics algorithm management system and so on. They will use their own optimisation algorithm system to jointly build B2C e-commerce reverse logistics decision support system. Information application module is mainly composed of recovery information management, recovery process tracking, recovery scheme optimisation, emergency scheduling management, member information management, recovery task management and fund settlement management. The specific operation logic of the B2C e-commerce reverse logistics information interaction system framework designed in this paper is shown in Figure 5.

Figure 5 Logic figure for information interaction system of reverse logistics in B2C e-commerce



According to the system operation logic of Figure 5, the network decision module is the central processor of the whole B2C e-commerce reverse logistics information interaction system framework. The logical relationship of the information interaction system at the module level is that the information perception module refines the market information into data stored in the B2C e-commerce reverse logistics database management system. The network decision-making module accesses the data from the port of B2C e-commerce reverse logistics database management system, and forms various concrete schemes after optimising the data. These solutions are transmitted to the information application module in an informational manner, and the information application module applies the optimised information to each work link of the reverse logistics operation system to achieve efficient improvement of the reverse logistics system. Finally, the information application module will make appropriate adjustments to the original action plan of each link in the reverse logistics system with reference to the optimisation scheme provided by the network decision module. This adjustment will inevitably destroy the balance of the original reverse logistics demand and supply. The adjusted information will be recognised again by the information-aware module, and a new round of module operation cycle will begin, eventually forming a new equilibrium of reverse logistics demand and supply.

In the framework of the entire B2C e-commerce reverse logistics information interaction system, each module has its own relatively independent operational logic. RFID system, M2M terminal equipment, sensor gateway and network, GPS positioning system are the technical core in the information perception module, which will capture the demand and supply information of system members on the reverse logistics in real time. For example, reverse logistics commodity information, the number of transport vehicles, size, model, location and load information, as well as the location of the warehouse, size, and load information. This information will be processed into transferable and stored data by the above core technology equipment, and then the data will be classified and stored in B2C e-commerce reverse logistics database management system for the purpose of data at any time or according to the type of data extraction.

In the network decision-making module, the decision-making system composed of various optimisation algorithms is the core part. These optimisation algorithms are not completely independent. After their optimisation, the data are shared within the module. For example, the data mining system will deeply mine the data provided by the information perception module to meet the needs of various optimisation models and various optimisation algorithms for data analysis. The process of data mining matching with various optimisation models is completed by the optimisation model management system. Similarly, the algorithm management system is mainly responsible for matching data mining with various optimisation algorithms. Data mining systems, optimised model management systems, and algorithm management systems require a reliable decision support system to secure their collaborative relationships in order to achieve consistent and continuous data sharing and collaborative operations. In this module, numerous optimisation models and algorithms are used to perform in-depth analysis of the data under the guarantee of the decision support system. Finally, the operational application scheme is provided to the information application module with a more operational implementation scheme such as emergency decision-making scheme, action optimisation scheme, route optimisation scheme, and evaluation feedback.

The content of the information application module is relatively rich, and all activities that can promote the growth of B2C e-commerce reverse logistics business belong to the content of the module. For example, information management of commodity recycling stations, process tracking of commodity recycling, optimisation of recycling schemes of recycling stations, emergency dispatch management, member management of B2C e-commerce reverse logistics system, management of commodity recycling tasks, management of corporate fund settlement, etc. performance of information applications. These specific information optimisation applications are based on the optimisation strategy provided by the network decision module, and the original action plans are appropriately adjusted. The adjusted actions, as new market information, will be captured and re-identified by the information perception module again, and then provided to the network decision-making module. Thus, B2C e-commerce reverse logistics information interaction system will be like this infinite dynamic cycle, to maintain the dynamic efficiency of B2C e-commerce reverse logistics system has always been optimised.

3 Possible system bugs

3.1 Bug in the process of system coordination operation

The premise of efficient operation of B2C e-commerce reverse logistics system is that 'information' can be accurately identified, quickly transmitted and fully shared in all links. However, the cost of related internet of things technology products such as RIFD, M2M terminals and various sensors is higher. The performance difference of these products is also large. In the system implementation process, if there is an information processing obstacle in a specific link in the whole system. No matter how efficient the information processing capabilities of other parts, it is possible that the entire B2C e-commerce reverse logistics system will be inefficient, and even the system may be paralysed. Therefore, the B2C e-commerce reverse logistics system designed in this paper only stays at the level of system operation logic, and the coordination optimisation of each module in the system needs further improvement which could be taken as the future research direction.

3.2 Information security bugs that may occur on the system

In the process of B2C e-commerce reverse logistics system operation, a large number of commercial information data such as commodity manufacturers, e-commerce, consumers, and logistics enterprises are implemented and shared within the system. If this information is leaked or illegally tampered with, it will have a serious negative impact on related companies and customers. However, in practice, every participant in the B2C e-commerce reverse logistics system except the consumer is very likely to become a window of information leakage. Therefore, it is difficult to realise the information security of the entire B2C e-commerce reverse logistics system by relying solely on the member credit in the reverse logistics cooperation system. To strengthen the security of information in the system, it is necessary to strictly restrict the network authority of each user in the reverse logistics system from the system level on the basis of member credit. From the technical level, it is imperative to ensure that the system gateway is not broken and that the software has the ability to resist internet attacks to ensure the security of entire B2C e-commerce reverse logistics system information. The bugs mentioned above do not belong to the logical defects of the system design in this article, which are difficult problems to be solved and would be the research focus in future.

4 Conclusions

The paper is aiming at the problem that traditional logistics mode is difficult to solve the fast-growing demand of reverse logistics in B2C e-commerce. With the help of the logic and ideas of the internet of things management, a B2C e-commerce reverse logistics cooperation system is designed and constructed based on three modules including e-commerce, information management and logistics management. Then, the information interaction system of reverse logistics is constructed with information perception module, network decision module and information application module as the core design. Finally, the basic framework of the B2C e-commerce reverse logistics system was built by the reverse logistics cooperation system and the information interaction system, and the possible system bugs were discussed. However, due to the limitation of the length of the article, the B2C e-commerce reverse logistics system designed in this paper is still only stays at the level of system operation logic. In the specific implementation process, system bugs such as 'coordination work of each module' and 'information security' need to be repaired and improved.

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