Research on Building Emergency Supply Chain Decision-Making Platform Using Big Data Mining Technology

Mai Ying(✉)

Guangzhou City Polytechnic, Guangzhou, People's Republic of China
1368256332@qq.com

Abstract. For public emergencies, building an emergency supply chain platform by using big data technology can quickly realize the supply of materials. Based on the analysis of the user needs of the emergency supply chain and the factors and constraints involved in resource scheduling, the emergency resources are uniformly allocated through intelligent scheduling and other methods with big data mining as the core, so as to achieve efficient operation and provide social support for public emergencies.

Keywords: Emergency Supply Chain · Decision-making Platform · Big Data Mining Technology

1 Introduction

Since the outbreak of the COVID-19 pandemic, President Xi Jinping has delivered many important speeches to emphasize that people's life safety and health shall always be taken as the top priority and that the pandemic prevention and control currently shall be the most crucial focus. Relevant government departments and some regions were busy transferring pandemic prevention materials to Wuhan through the central medical reserve and were also rapidly organizing enterprises to resume work and production. In accordance with the data released by the Ministry of Industry and Information Technology of the People's Republic of China (MIIT), 154,500 pieces of medical protective clothing, 133,600N95 facial masks, and 82 sets of full-automatic infrared detectors have been dispatched to Hubei Province from all over China by February 2, 2020. Fortunately, the pandemic prevention materials have changed from an emergency state to a "tight balance" and progressively stayed "stably balanced". This sudden pandemic, occurring in China, a state with a large population, along with the dense flow of people during the Spring Festival and the shortage of emergency supplies, has made it such a matter worthy of discussion and research as how to effectively protect people's lives and maintain the stability of the whole society.

Supported by Guangzhou Innovation Team Scientific Research Project: Innovation team of emergency materials collection and dispatching management under major emergencies (202032794); The innovation team project of Guangdong Province universitier: Collaborative Innovation Research Term of Guangdong Strategic Emerging Industry Group (2020WCXTD032)

A. Li et al. (Eds.): 6GN 2022, LNICST 504, pp. 122–129, 2023.
https://doi.org/10.1007/978-3-031-36011-4_11

As science and technology continuously develops in China, we have entered into an era of computer network and to this day, computer network technology is being applied in a host of fields, encompassing a key one, namely, emergency management. In the operation and management of enterprises or society, the occurrence of sudden emergencies may exert an adverse influence upon the stability and safety of enterprise and social operation. Nevertheless, the implementation of emergency management measures can greatly alleviate the harm engendered by emergency accidents. In this regard, it is vital to handle emergencies in a scientific and reasonable way. China is now facing some conspicuous challenges about the emergency resources, such as insufficient investment, low degree of resource integration, and inadequate management performance. To change the status quo, the supply chain management of emergency materials dispatch can be adopted to advance cities' capability of emergency resource guarantee.

Emergency supply chain decision-making is quite sophisticated, which is composed of a series of decisions and involves the balance of multiple parties' interests. Also, the decision-making entities are diversified, the decision-making behaviors are highly complex, and the structure of the problem is not clear enough. Therefore, scientific decision-making mechanisms and methods have to be established.

2 A Decision-Making Mechanism of Emergency Supply Chain and Data Mining Technology

2.1 A Decision-Making Mechanism of Emergency Supply Chain

The research idea of emergency supply chain management derives from "the research of airlines' emergency management system". The term of emergency management was initially proposed by Causen et al. and later, in the case of demand fluctuation spawned by emergencies, Qi X. (2019) probed into the situation of a certain linear demand function where the quantity discount contract was adopted in the supply chain to deal with these emergencies. Subsequently, Xu M. et al. (2020) made a similar study on the case of the nonlinear demand function. Lei Z. and Xu J. P. (2021) defined and classified emergencies in the supply chain, and further proposed the system, organization, and process of emergency management in supply chain emergencies.

Yu H., Chen J., and Yu G. (2020) conducted research on the impact of emergencies on the supply chain coordinated by quantity discount contracts, and proposed a quantity discount contract with the feature of emergency resistance. Veronneau S. and Roy J. (2021) studied the characteristics and major influencing factors of the supply chain of dynamic global cruises. It is fair to say that Case Based Reasoning (CBR) is a paramount reasoning method in the field of artificial intelligence.

2.2 Data Mining Technology Employed in Emergency Decision-Making

To date, the data mining technology adopted in emergency decision-making chiefly encompasses: an AI Agent system with autonomous reasoning and decision-making capability to simulate and optimize the operation of the control supply chain, which has already become one of the pivotal methods in the research of supply chain. Swam M. et al. applied the multi-agent method to model the supply chain; Kalakota et al. used the Multi-Agent Simulation Model for What-if analysis, and Nissen employed a general business model to elucidate the process between Buy-Seller with Agent. Case Based Reasoning (CBR) was first proposed by Professor Schank of Yale University in a monograph published in 1982. Since the late 1980s, scholars in foreign countries have systematically studied this theory, and made some practical achievements in the fields of general problem solving, legal case analysis, auxiliary planning and others. Fu Y. et al. introduced CBR into the risk estimation of the supply chain, and effectively solved the key problems of case description, storage organization, matching case retrieval.

Bayesian Network and Bayesian Inference: in terms of supply chain emergency risk management, Roshna et al. established a risk analysis model of NTT supply chain by adopting Bayesian Network, which can help analyze the risks in the production and distribution links. Hu X. X. et al. (2017) discussed the application of Bayesian Network in supply chain emergency management. And the Method of Support Vector Machine, a machine learning algorithm based upon statistical learning theory put forward by Vapnik et al. of Bell Laboratories in the 1990s, has been extensively employed in realms of pattern recognition, data mining, nonlinear system control, modeling, distribution forecasting, collaborative early warning of supply chain partners, and supply chain performance evaluation.

3 Overall Scheme Design of the Platform

3.1 Overall Structure of the Platform

To alleviate the shortage of emergency resources in case of any emergencies, this study combines big data technology to construct a platform integrating five central links, namely, intelligent reservation, intelligent order distribution, intelligent scheduling, intelligent distribution and intelligent after-sales. Furthermore, the platform is divided into eight subsystems pursuant to business function modules, including customer center, supplier management, intelligent distribution, trading platform, scheduling center, intelligent after-sales, statistical analysis and rights management (see Fig. 1).

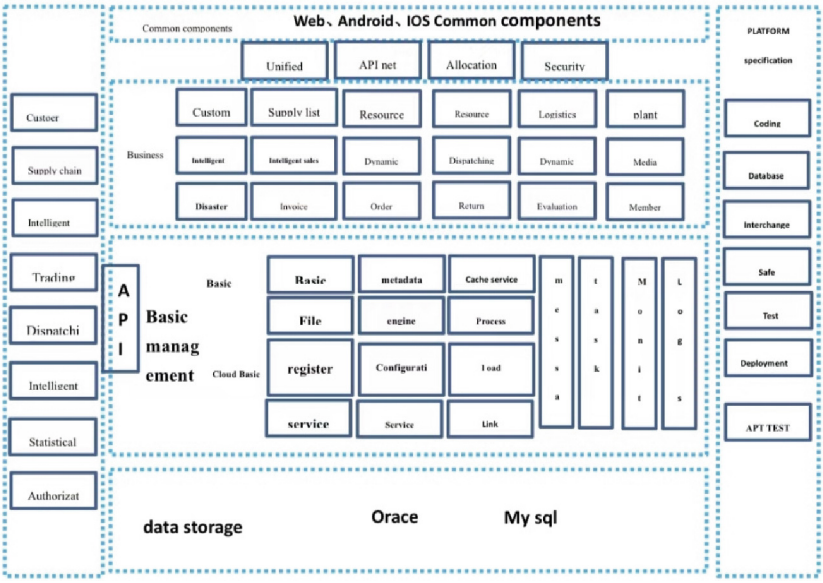

Fig. 1. Platform System Architecture

3.2 Platform Businesses

In case of sudden disasters, the platform provides intelligent scheduling, production and distribution services of emergency resources, and adopts big data to comprehensively carry out intelligent reservation; intelligent order distribution, intelligent scheduling, intelligent distribution, intelligent after-sales and evaluation services (see Fig. 2). The target users of the platform primarily involve enterprises and institutions, scientific research institutes, government departments, self-employed households, social individuals and others.

Whenever a major disaster occurs, the platform will release a corresponding special feature. Upon the release, it is necessary to distinguish the disaster type to which it belongs (meteorological disaster, marine disaster, flood disaster, geological disaster, earthquake disaster, forest-related disaster or pandemic disaster) [5]. Then, the corresponding emergency resources under different disaster types can be allocated through the classified management function of system rights management. For instance, the platform released the special feature of NCP in 2019 and the disaster type was classified into pandemic disaster, so that the system preset the following emergency supplies according to its type, such as facial masks, protective goggles, protective clothing, medical gloves and oxygen respirators. Additionally, when the supplier entered into the system, they were also required to select the disaster type in the first place and then set the emergency supplies to provide.

When a customer makes a reservation for emergency supplies, the system will conduct intelligent order distribution after the intelligent matching of the suppliers. If the reservation is made successfully, the customer will be required to pay the order successively; after this phase, the supplier can set about conducting material production and providing distribution services. In the phase of intelligent scheduling, the system provides the manual scheduling function based upon the relevant national strategic deployment requirements, and gives priority to the scheduling in the worst hit areas as well as the allocation of emergency supplies from suppliers. For example, in this NCP pandemic, the platform could conduct artificial intelligence (AI) scheduling for Wuhan and other cities in Hubei Province, gave priority to intelligent scheduling of emergency resource reservation orders in this region, and prioritized suppliers to provide emergency material production and distribution services.

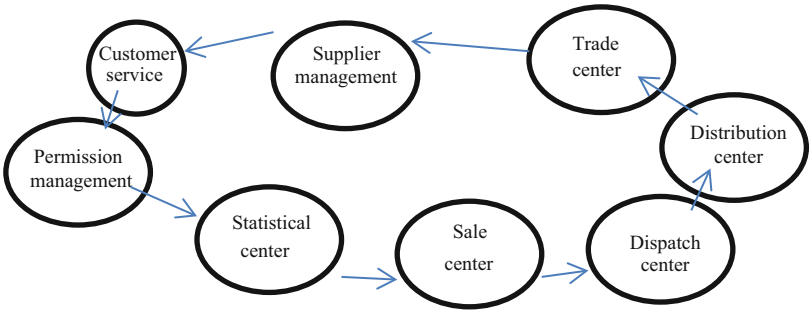

Fig. 2. The Business Process of Platform

When a major emergency disaster occurs, the platform will publish a feature about the disaster. In order to publish the feature, the platform user needs to confirm the type of disaster to which it belongs (e.g., meteorological disaster, marine, flood, geological disaster, earthquake, forest-related disaster, or epidemic disaster) and then set the emergency resources corresponding to the different pandemic types through the category management function of the system rights management. For example, if the platform releases the feature about the 2022 COVID-19 pandemic and chooses the disaster type as a pandemic disaster, the system will present the following emergency supplies, including masks, protective goggles, protective clothing, medical gloves, and ventilators. In addition, suppliers will also need to confirm the disaster type when entering the system and then set the emergency supplies to be provided.

When a customer makes a reservation for emergency supplies, the system will intelligently dispatch the order after matching the supplier in an intelligent way, and require the customer to pay for it if the reservation is successful; after the order is successfully paid, the supplier will produce the supplies and provide delivery services. In the intelligent dispatching link, the system provides an artificial dispatching function based on the requirements of the relevant national strategic plan, giving priority dispatching to the hardest hit areas and assigning suppliers to provide emergency supplies. For example, in the face of the COVID-19 pandemic, the platform can perform artificial intelligence

(AI) dispatching for Wuhan and other cities in Hubei Province, prioritizing the intelligent dispatching of emergency resource booking orders for these regions and assigning suppliers to provide emergency supplies production and delivery services.

3.3 The Specific Functional Design of the Platform

(1) Customer Centre. It includes several subsystem functions such as my appointment, shopping cart, order management, logistics management, invoice management, after-sales management, personal settings, security settings, and real-name authentication. The order management module supports the order payment function. After a successful booking of emergency supplies, the system interface will jump to the order payment page. Not only that, customers can choose to pay for their orders through the order management page. As the core module of the platform's financial business, the payment module has a relatively high-security demand required to use Hypertext Transfer Protocol Secure for transactions.
(2) Supplier Centre. It includes order management, production management, logistics management, invoice management, after-sales management, personal settings, security settings, real-name authentication, capacity settings, and other subsystem functions.
(3) Transaction Centre. It includes four subsystem function modules of order management, dispatch management, invoice management, and after-sales management.
(4) Distribution Centre. It includes four subsystem function modules: logistics distribution, air distribution, express distribution, and dedicated distribution. The distribution center is able to distribute emergency resources in an intelligent, orderly, and efficient way.
(5) Dispatch Centre. It includes six sub-system functional modules: requisitioning enterprise resources, dispatching enterprise receiving orders, dispatching enterprise distribution, dynamic monitoring of resources, dynamic monitoring of resource supply and demand, and dynamic monitoring of resource distribution. The dispatch center enables emergency resources to be allocated intelligently and rationally to solve the resource scarcity in a rapid way.
(6) After-sales center. It includes five sub-system function modules: cancellation of transactions, refund management, return management, complaint management, and AI customer service center. The after-sales center provides quality after-sales service, including 24-h online customer service, customer hotline, material reporting service, and AI customer service consulting services for products.
(7) Statistical analysis. It includes nine subsystem function modules: resource inventory statistics, resource capacity statistics, resource distribution statistics, resource shortage warning, customer statistics, supplier statistics, order statistics, appointment statistics, and dispatch statistics.
(8) Rights management. It includes seven subsystem function modules: classification management, business dictionary, system information, account management, role management, menu management, and AI database management.

4 The Expected Application of the Platform

According to the Urgent Notice by the General Office of the State Council of Effectively Organizing the Resumption of Operation and Production of Manufacturers and the Scheduling of Key Supplies for Epidemic Prevention and Control, a cohesive work mechanism should be established to ensure 24-h smooth liaison and deal with coordinated works, including the timely production, allocation, transportation and distribution of key medical emergency prevention and control materials. The platform is able to provide rapid supply and demand matching services for major disaster events. According to the nationwide production demand reflected centrally on the platform, the platform is able to dispatch orders to the corresponding suppliers through intelligent allocation; at the same time, this platform represents several sectors, such as intelligent reservation, intelligent order distribution, intelligent scheduling, and intelligent after-sales big data services to build an intelligent docking platform for customers and suppliers. Overall, the platform is able to efficiently dispatch global resources and global suppliers, seamlessly matching production and demand, reducing resource waste, and speeding up resource supply. Regional linkage of emergency resources is at the core of regional emergency linkage and establishing regional linkage of emergency resources is necessary to make up for the shortage of emergency resources, improve the efficiency of the use of emergency resources and effectively respond to major emergencies across administrative regions. In addition, under the influence of mass media and the benefits of the internet, the platform can rally social forces and provide huge social support for major disasters, and therefore serve as an intelligent demonstration platform for big data emergency resources.

5 Conclusion

The platform built in this research provides strategic emergency resources for major disasters through big data technology for intelligent reservation, intelligent order distribution, intelligent scheduling, and intelligent after-sales. This platform is able to achieve intelligent matching of supply and demand as well as dynamic monitoring by dispatching global suppliers in a fast and intelligent way, which can satisfy the demand for emergency resources under disaster situations, providing a third-party emergency resource service platform for the prevention and control of major domestic disasters as well as a powerful strategic emergency resource guarantee service platform for the prevention and control of natural disasters, natural pandemic and other major disasters in China. In addition, the platform provides a whole process support service from customer booking; order dispatching, payment, allocation, scheduling, production, distribution, and after-sales, providing an effective demonstration for solving the problem of resource shortage in the face of major disasters.

References

1. Xinhuanet. Take epidemic prevention and control as the most important work at present [EB/OL]. http://www.xinhuanet.com/politics/2020-01/27/c_1125506288.htm. Accessed 02 Feb 2020

2. Xinhuanet. Always put the people's life safety and health first: resolutely win the fight against epidemic prevention and control [EB/OL], 05 February 2020. http://www.xinhuanet.com/2020-02/05/c_1125535838.htm. Accessed 02 Feb 2020
3. Jiang, W.: Application of big data in emergency management. Electron. World (10), 79–80 (2019)
4. Chen, G., Duan, Y.: Suggestions for improvement of emergency resource management in China. Shanghai Manag. Sci. (4), 44–45 (2006)
5. Emergency management department. Natural disaster type [EB/OL], 02 February 2020. https://www.mem.gov.cn/kp/zrzh/qxzh/. Accessed 02 Feb 2020
6. Guo, H.: Analysis of advantages and disadvantages of HTTPS for website security. Comput. Netw. (5), 50–51 (2017)
7. Xinhua News Agency: The general office of the State Council issued the emergency notice on organizing and arranging the resumption of production and scheduling of key material production enterprises for epidemic prevention and control [EB/OL], 30 January 2020. http://www.gov.cn/xinwen/2020-01/30/content_5473212.htm. Accessed 02 Feb 2020
8. Xu, M., Qi, X., Yu, G.: The demand disruption management problem for a supply chain system with nonlinear demand functions. J. Syst. Sci. Syst. Eng. **12**(1), 1–16 (2019)
9. Véronneau, S., Roy, J.: Global service supply chains: an empirical study of current practices and challenges of a cruise line corporation. Tour. Manag. **30**(1), 128–139 (2019)