RESEARCH ON EMERGENCY LOGISTICS DYNAMIC NETWORK BASED ON SUPER-NETWORK

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Abstract— In order to improve the adaptability of emergency logistics network in the complex environment, operation mechanism about this network is studied by using super-network theory. Based on this, an optimization model of emergency logistics dynamic network is established based on super-network to ensure emergency supplies arrive in time, and improved ant colony optimization algorithm is proposed to solve this model. Finally, a case study is carried out to verify the validity, objectivity and applicability for this model and its optimization algorithm through calculated and analyzed practical data. From the test results, it is shown that the adaptive capacity can be improved by timely cooperating for each body in the network.

Keywords— emergency logistics network, super-network, ant colony optimization, multipath

I. INTRODUCTION

With the natural disasters taking place frequently, emergency logistics has become a current topic in recent years. As we all know, emergency logistics network plays an important role in rescuing, therefore, some scholars have done lots of achievements about it.

Aksen and Aras (2012), Arabani and Farahani (2012) and Farahani et al. (2013) have studied the emergency facility location problem (FLP). Meanwhile, another part of the scholars have studied the emergency supplies allocation problem (AP), such as Sheu (2007), Altay (2013) and Najafi et al. (2012).

Optimization problem of emergency logistics transportation network is a typical multi-path selection problem with the multi-factor variation, such as the uncertainty of vehicle routing and the randomness of abnormal congestion events, etc. Haghani and Oh (1996) had presented a multi-commodity, multi-modal network flow model for disaster relief operations. Ozdamar et al. (2004) had proposed a mixed multistage integer programming model which solved by the Lagrangian Relaxation Technique. Ye et al. (2013) had applied Bayesian analysis and optimization theory to establish emergency logistics system model which solved by the genetic algorithms. Afshar and Haghani (2012) had proposed a modeling integrated supply chain logistics in real-time large-scale disaster relief operations. Zhu and Li (2014) had analyzed the operation mechanism of virtual emergency logistics coupled collaborative system. About research methods, relevant scholars have studied this problem based on the network flow model, using the game theory (Gupta, 2004), scenario planning (Chang et al., 2007) and cooperative strategy (Sha and Huang, 2012). Existing research achievements have laid a certain foundation for this problem.

Existing researches have realized the optimization goal in some degree, but majority of them pay little attention to the emergency environment and models in those researches do not have obvious dynamic and adaptability to complex environment. Therefore, this article analyzes the complex environment and uses super-network theory to explain emergency logistics network. By presenting operation mechanism, the network’s adaptive capacity to complex environment is improved. Besides, in order to make sure the timeliness of emergency supplies, a multipath mathematical model is also established under this operation mechanism.

II. ANALYSIS OF EMERGENCY LOGISTIC NETWORK

Unexpected emergency makes the emergency logistics network more uncertainty. Besides, it also may lead to secondary disasters. In return, those secondary disasters badly affect the operation of emergency logistic network (Chen et al., 2011). So, it is very complex to environment about emergency logistics network. In order to reduce this negative effect, the network must have perception to the complex environment.

Combining with the three-dimensional management system in China, government organization network can be presented according to emergency logistics transportation network. The relationship between two networks is that each node in governmental organization network manages a specific node in transportation network respectively. The management can be regarded as monitoring and information feedback. By this management, the perception and reaction between transportation network and complex environment can be realized. As information flow existing during the whole management, information network should also be proposed. Thus, there are three level networks in this emergency logistics network.

1) Multilayer characteristics. The corresponding nodes in different network (transportation network, organization network and information network) are interrelated, but all of them have different properties. It shows that emergency logistics network has characteristic of multilayer.

2) Multi-attribute. Many standards can be used to value emergency logistics, like timeliness, economy and security, and all of them can show that emergency logistics network has characteristic of multi-attribute.