ISSN: 1813-4890

Literature Review of Medical Waste Recycling Pathways

Yi Huang [a], Dingnan Ye

School of Economics and Management, Southwest Petroleum University, Chengdu, 610500, China

[a]1500932354@qq.com

Abstract

This paper provides a comprehensive literature review of the field of pathway optimization for medical waste recycling, aiming to summarize and analyze the classification of medical waste and the pathway optimization for recycling, and to study the current state trends and key issues. Path optimization has been a core of a logistics and transportation, and its impact has been widely manifested in social, technological and economic fields. This review includes several key aspects in the field of medical waste classification, vehicle path optimization, such as technological innovation, policy and ethics, and future perspectives. Firstly, this paper reviews the historical development of the field of medical waste sorting and vehicle path optimization, highlighting the remarkable progress made within the last few decades, and we emphasize the importance of technologies and trends such as Big Data, Artificial Intelligence, automation, and sustainability for medical waste recycling research. Second, this paper analyzes the challenges facing the field of medical waste recycling. These challenges include data privacy, ethical and moral issues, and the feasibility of technological applications. We emphasize the importance of how to deal with these issues in practice and suggest some possible solutions. Finally, this paper explores future perspectives for research on healthcare waste pathway optimization. We believe that the issue of vehicle path optimization for medical waste still needs to be improved and modified, and with in-depth practical research, it can provide a certain decision-making basis for relevant recycling companies and promote innovation and sustainable development on a global scale.

Keywords

Medical waste recycling; vehicle path optimization; green logistics.

1. Introduction

China's medical waste disposal industry started in the 1980s, in 1989, the People's Republic of China Infectious Disease Prevention and Control Law was promulgated, the disposal of medical waste and regulation of clear provisions. 2003 SARS outbreak, China's medical waste disposal capacity is insufficient to fully expose the shortcomings. Objectively speaking, each epidemic has promoted the continuous improvement of China's medical waste disposal system. 2003 SARS outbreak, China introduced a series of normative measures, such as the "Centralized Disposal of Medical Waste Technical Specification", "Regulations on the Management of Medical Waste", "Measures for the Management of Medical Waste in Medical and Health Institutions", etc. Thus, China has entered a new era of medical waste disposal. As a result, China has entered a new stage of standardized management of medical waste. Various regions have stepped up the construction of medical waste disposal facilities, the industry has entered a period of rapid development. 2020 national medical waste production will increase by more than 25%, medical waste disposal industry has become one of the industries that accelerated growth after the epidemic. It can be expected that, with China's medical waste disposal industry standards,

policies continue to improve and policy support to increase, medical waste disposal industry will attract more social capital to enter, and promote the standardization of the industry.

At present, China's medical waste disposal industry development momentum is good. As the medical waste disposal industry is usually a prefecture-level city only a license, so medical waste disposal enterprises often have a monopoly in the local area, medical waste disposal industry investment returns are relatively stable, attracting a lot of social investment.

But China's medical waste disposal rate is relatively low, the medical waste disposal market still has a large room for improvement. On the medical waste disposal industry market size, even if not affected by the epidemic, in the next few years, the amount of medical waste generated and the industry market size will maintain a certain degree of growth, 2025, China's medical waste disposal market size or nearly 12 billion yuan.

With the development of China's urban medicalization, the amount of medical waste is also growing, coupled with people's awareness of environmental protection and waste disposal issues continue to strengthen, the treatment of urban medical waste has become one of the focus of attention, but China's urban medical waste reverse logistics development is still in the primary stage of development compared with developed countries. In order to avoid the waste of valuable resources in medical waste, and at the same time to protect the environment and safeguard people's health, it is particularly important to establish a standardized, systematic and efficient urban medical waste reverse logistics network.

2. Research significance

2.1. Enrichment and development of reverse logistics theory and algorithm design methods

Although scholars at home and abroad have made a lot of achievements for the optimization of the collection and transportation system of domestic garbage waste, due to the special nature of medical waste and the suddenness of its special public health crisis, the recovery and transportation method of medical waste is not the same as domestic garbage waste in some aspects, and there are fewer studies on the reverse logistics of medical waste, and this paper enriches and develops the theory of reverse logistics of medical waste to some degree. This paper enriches and develops the theory of reverse logistics of medical waste to some extent. At the same time in the design of the algorithm, through many scholars on the application of genetic algorithm for in-depth study found that there are defects in its local search ability is poor, so in order to improve the search ability of the genetic algorithm, this paper will climb the mountain algorithm combined with the genetic algorithm which has excellent global search ability, climbing the mountain algorithm is a kind of algorithm which has good local search ability, this paper enriches and develops the traditional genetic algorithm.

2.2. Provides a decision-making basis for related medical companies

First of all, the recycling and treatment of medical waste is crucial for environmental protection and public health. By studying the recycling path of medical waste, the pollution of waste to the environment can be effectively reduced and the potential threat to health caused by waste can be reduced. By improving the recycling path, the transportation cost and time of waste can be reduced, and the timeliness and feasibility of recycling can be improved. Meanwhile, rational utilization of recycled waste resources can also reduce the company's production costs and improve economic efficiency. The study also contributes to the brand image and social responsibility of medical companies. Recycling and disposal of medical waste is an area of social significance and public concern. By improving and optimizing the recycling path, it can demonstrate the company's environmental protection concept and pursuit of sustainable

development, and enhance the company's image and reputation in the eyes of society and customers.

3. Literature review

3.1. Current status of domestic and international research

At present, in the research field of waste recycling, there is sufficient research literature at home and abroad, but there is a lack of medical waste recycling. Entering "Waste recycling" in Elsevier database, we found 267122 articles with some related documents; entering "Waste recycling" in CNKI database, we found 494 related documents. Entering "medical waste recycling" in Elsevier database retrieved 32751 articles, and entering "medical waste reverse logistics" and "medical waste recycling" in CKNI database retrieved 494 articles. In the CKNI database, 125 articles were found by typing "medical waste recycling" and "reverse logistics of medical waste". Entering "Path optimisation of medical waste recycling" in the Elsevier database retrieved 4458 articles with some relevance, and entering "path optimisation of medical waste recycling" in the CKNI database retrieved 4458 articles with some relevance. Path optimisation of medical waste recycling" in the CKNI database, 35 articles were found. From the above data, it can be found that the research on waste recycling is relatively mature, especially the recycling of electronic products, but the research on medical waste started earlier in foreign countries, and the research in China is relatively small.

3.2. Current status of research on waste recycling

Current research on waste recycling includes a selection of waste recycling models and research methods for waste recycling.

(1) Study on the selection of waste recycling modes

Based on the perspective of recycling efficiency, Savaskan (2004) constructed a game model of recycling modes in a closed-loop supply chain environment and classified it into four modes: unified recycling, producer recycling, retailer recycling, and third-party recycler recycling .Huiming Zhang et al. constructed a dynamic game model between biofuel companies and recyclers, and compared the recycling modes and recycling rate decisions of waste cooking oil to biofuel in China and Japan, and concluded that the recycling efficiency of the Chinese model is not necessarily lower than that of the Japanese model in theory. Zhang et al. (2020) proposed a framework for solving the construction and demolition waste recycling model selection problem in a heterogeneous group decision-making environment, and concluded that off-site crushing and backfilling of roadbase is the optimal mode . Konstantin Born et al. (2023), in order to assess the potential of recycling strategies in meeting future metal demand and replacing primary productivity, developed a new dynamic probabilistic material flow analysis (MFA) model, which explores the potential of recycling to reduce metal mining activities .

By summarising and analysing three recycling models based on ERP and direct producer responsibility, Wu Yuping (2011) proposed the responsibility transaction system recycling model with indirect producer responsibility . Cai Key (2013) found that 90% of farmers support recycling and their attitude is influenced by the level of knowledge of pesticides, so the government-led recycling model should be chosen in the short term, and then gradually guide farmers to choose the market-led recycling model by continuously improving their knowledge of pesticides . The government-led recycling model should be chosen in the short term. In order to explore the impact of different information environments on the recycling inventory, Ma Zujun et al. (2016) constructed a game model of three different recycling modes with and without government regulation . Li Zhengjun and Zhang Zhen (2019) used the entropy weight method and Borda selection model to select and evaluate the recycling mode of packaging waste, with a view to improving the recycling rate of packaging waste in China . In the context

ISSN: 1813-4890

of the study of chemical waste reverse logistics, Li Deqing et al. (2020) conducted a comparative study of enterprise self-operated, logistics alliance and third-party recycling modes by constructing an index evaluation system, and the results showed that the outsourcing recycling mode was the best . Zhu Yu (2023) firstly combed the current situation of agricultural waste recycling and its recycling logistics mode, and clarified the main constraints affecting agricultural waste recycling. A three-party evolutionary game model is constructed for evolutionary stability analysis, and the key factors affecting the evolutionary stability of the model are analysed in depth. Finally, a system dynamics model is constructed based on the tripartite evolutionary game model, and different evolutionary states are simulated by adjusting the parameters to further explore the specific evolutionary paths . The model is further analysed by adjusting the parameters and further exploring the specific evolutionary paths.

(2) Research on waste recycling research methodology

From the collected literature, there are both qualitative and quantitative methods of analysis for waste recycling, but the main focus is on quantitative analysis with three main research methods such as mathematical modelling, gaming, and empirical analysis.Ravi and Shankar (2005) studied the barriers affecting the implementation of recycling in the automotive sector using the ISM methodology . Tiffany M (2018) identified, prioritised and quantified the relationship between potential variables of food waste in Hong Kong's hotels, restaurants and other industries. Questionnaire data was analysed through qualitative analysis of content and quantitative structural equation modelling, which concluded that food waste recycling behaviour is determined by three latent variables - administrative incentives and business support, logistical and managerial incentives, and economic incentives. He (2020) explored the optimal strategies for BME and WRE by considering consumers' perceived quality of recycled materials. A model was developed using game theory to analyse stakeholder decisions under different construction waste recycling scenarios .

Xie, Jiaping et al. (2003) quantitatively analysed the cost-effectiveness of used and end-of-life household appliances from three perspectives: reuse of parts, reuse of materials and safe disposal, using a job-based cost analysis methodology . Tiger Chenxia et al. (2010) used multivariate analysis to study the perceptions and recycling patterns of 77 enterprises in Zhejiang Province on the recycling of used and end-of-life electronic products . Xu Minli et al. (2018) studied the competition and cooperation between e-waste recycling enterprises and mobile recycling vendors against the background of "Internet + Recycling", and constructed an evolutionary game model of e-waste recycling . In order to explore the factors influencing the recycling of express packaging waste in urban communities, Lin Hongtao (2018) used principal component analysis to analyse the questionnaire data, identify the main and objective factors affecting the residents' participation in recycling behaviour, and simulated the role of each factor on the residents' participation in recycling behaviour by using the system dynamics and other methods, in order to reveal the mechanism of its effect . Yan Yaling (2022) studied the decision-making problem under different games constituted between formal and informal recycling channels, and simulated the effects of parameters such as the cost of the processor, the cost of the recycler, and the recycling quality threshold of e-waste on the pricing decision through numerical simulation and analysed the efficiency of the government subsidy in this stage. The game models of formal recycling enterprises and informal recycling enterprises in the development and maturity periods are constructed respectively, and the pricing decisions under the three different periods are analysed and compared, and the mathematical model derivation is used to prove that the government subsidies have very different efficiencies for the formal recycling enterprises in different periods. The mathematical model is used to demonstrate that the utility of government subsidies is very different for formal recycling enterprises in different periods.

ISSN: 1813-4890

3.3. Current Research Status of Medical Waste Recycling

Current research on medical waste recycling mainly includes medical waste collection and treatment, medical waste treatment methods and management systems, and optimisation of pathways for medical waste recycling.

(1) Medical waste collection and disposal

In the 20th century, the United States and other developed countries in the world gradually stepped into the era of industrial civilisation, and the increasingly better quality of life led to the emergence of more and more various types of waste, medical waste is one of them. As the treatment of medical waste was not standardised at that time, a large amount of medical waste was brought to the beach by seawater, which posed a great potential danger to the physical and mental health of nearby residents and tourists, so early scholars paid more attention to how to deal with medical waste.As the earliest batch of researchers and scholars, Cross put forward a number of corresponding treatment modes, which can help the relevant departments and enterprises to solve common problems in the process of dealing with this kind of waste. Cross, as one of the earliest researchers, proposed some treatment models to help the relevant departments and enterprises solve the common problems in the process of handling such waste. Over time, more and more scholars have conducted research in this area. Debita has studied the medical waste management model in private hospitals and predicted the problems that may exist in the collection and management of medical waste. Mantzaras conducted a comprehensive study on medical waste and designed an optimisation model for waste collection and disposal that is suitable for most regions, combining various sophisticated tools such as simulation and identification, and using software such as Mapinfo to solve and validate the model .The model was validated using software such as Mapinfo.

In the domestic Xu Henggang and Wei Xia combined with the new crown epidemic and domestic relevant policies and regulations, the current domestic medical waste definition, classification, and treatment of the current situation is outlined. In China Zhang Wenwen summarises the latest research data, explains the hazards of medical waste, describes the treatment methods for different types of medical waste, suggests that the hazards are caused by unregulated management, and gives recommendations for the management of relevant medical waste. The reason for the harm is caused by the unregulated management. Huang Zhengwen makes a comparative analysis of the new medical solid waste treatment technologies such as disinfection and sterilisation, sanitary landfill, incineration and pyrolysis, which are common in our country, and clarifies the advantages and disadvantages of the various methods in practical use. The advantages and disadvantages of the various methods in practical use are clarified. Chen Wei introduces the concept of cloud management into the study of medical waste management, analyses the framework of the Internet of Things, cloud technology and its main system functions, evaluates the effectiveness of cloud management in the whole life cycle of medical waste disposal, and combines with the First People's Hospital of Yancheng City to carry out operational empirical analysis .

(2) Management system for medical waste disposal

Bahar (2004), in constructing a two-layer planning model and applying a designed vehicle transport network for hazardous waste in the city of Toronto, explored solutions to the problem of transporting urban waste. Aylin et al. (2008) used the city of Istanbul as a research object to optimise the collection and transport routes of medical waste in the region, comprehensively assessed the locations involved in transporting medical waste, the condition of the equipment, and optimised the transport routes in order to provide a solution for the city to reduce the cost of medical waste disposal.Nguyen et al. (2020) collected residual ash from a municipal medical waste incineration plant and other waste incineration plants and analysed the content of dichlorobenzene in the different wastes, and found that the composition of dichlorobenzene

produced varied greatly between residual ash and incinerators, suggesting that the formation of hazardous substances in medical waste is affected by a variety of factors. Saeed (2020) considered how medical waste can be handled optimally under uncertainty of medical waste production and other standard parameters of medical waste management, and analysed and illustrated the potential of the model for predicting uncertainty in medical waste by establishing a linear programming model under uncertainty, and also calculated the amount of medical waste transferred between different nodes so as to strengthen the nodes for medical management of medical waste. Krishna et al. (2020) obtained non-hazardous medical waste from medical waste lids as a reinforcing material to make a new composite material to increase the use of medical waste for medical waste recycling. Yukihiro (2019) found that the production of medical waste in hospitals is affected by the department by comparing the infectious medical waste produced in different departments, especially in hospitals with many intensive care departments, the production of medical waste is high, this finding is very important for infectious medical waste management in hospitals with intensive care departments. This finding is very important for the management of infectious medical waste in hospitals with intensive care units.

Liu Rui, Zhang Jiansheng et al. (2016) conducted an in-depth study on the medical waste recycling and disposal model of village health rooms in Banan District, Chongqing, and proposed that for the areas where the system is inflexible and unreasonable, and where there are no local supporting regulations, we should increase supervision, organise professional training for healthcare personnel, improve the quality of healthcare personnel, and increase the rate of centralised disposal of medical waste, which is the main way to address the chaotic status quo of medical waste management in the countryside . Huang Liang, Zhang Dongmei et al. (2019) evaluated the management of medical waste in primary healthcare institutions in Anhui Province, and concluded that the problems prevalent in collection, transport, storage, treatment, and personnel training are of guiding significance for the evaluation indicators of medical waste management systems in other regions of China. Liu Bin (2018) conducted an analytical study on the economics of the medical waste management system in Shanghai, mainly focusing on the current status of the treatment of different types of waste and the market price, the relationship between management systems, institutions and treatment costs, stressing the need to establish a free price adjustment mechanism and the use of decentralised treatment of medical waste, which can reduce the cost of medical waste treatment . Zhang Ying (2015) conducted a summary study on the current situation of medical waste treatment in the north of China, elaborated on the applicability of different medical waste treatment methods in the north, and put forward four kinds of countermeasures for the treatment of medical waste in the north: increasing the classification and management of medical waste, increasing the investment in the construction of facilities, recycling medical waste for a fee, and increasing the strength of the legal management of the treatment of medical waste. The following is an example of the four measures for medical waste treatment in the north. Chang Hong (2013) and others described the current situation of medical waste management in Ningxia and proposed corresponding countermeasures for the existing problems. Shi Jing et al. Shi Jing et al. (2019) analysed the research results included in the CNKI database in recent years on medical resources as keywords, mainly discussing the authors of the papers, affiliations, and high-frequency words of the research results, in order to grasp the current status of the research on the allocation of medical resources, and also through this study, to further understand the current relationship between medical resources and medical waste in China, and to conduct research on the Limitations and research prospects are further understood. He Zhengzang et al. He Zhengzang et al. (2016) mainly used system dynamics to analyse the relationship between the relevant elements affecting the construction of the medical waste logistics network, determined that the relationship between the elements is causal, and then determined the

evolution model of the medical waste logistics network . Zhao Shuairan et al. (2018) analysed the current situation of medical resource allocation in Beijing, pointed out that the utilization rate of medical waste is low, and put forward the countermeasures of rationally allocating medical resources and improving the utilization rate of medical waste, so as to provide feasible suggestions for reducing the pressure on China's medical resources . Li Yang (2015) takes Liaoning Province as the research object and applies an improved genetic algorithm to construct a medical waste reverse logistics network, so as to determine the optimal reverse recycling logistics network to provide a new research approach . Li Yue et al. (2019) analyse the current situation and problems of medical waste treatment in remote areas in China, and put forward a targeted management model for medical waste in remote areas in view of the objective conditions, transportation distance, technology and other factors existing in remote areas. The model of medical waste management in remote areas is proposed. Huo Qingqing et al. (2020) Aiming at the production of medical waste and the uncertainty of recycling demand, and part of the medical waste is hazardous to human health, we constructed a sustainable medical waste recycling network model to minimise cost and harm, and solved the problem of medical waste treatment . Fang Shuqi et al. (2019) studied the solid waste treatment technology in medical waste, compared the current situation and problems of treatment, found the shortcomings, and concluded that pyrolysis is still the optimal technology for treating medical waste, and it also provides a reference basis for the selection of technology for treating other medical wastes. It also provides a reference basis for the selection of other medical waste treatment technologies. Zhao Jingwei (2010) established a multi-objective planning model for medical waste collection, storage and transport routes, introduced fuzzy factors into the research problem, and analysed the problem to find out the root cause of the problem, proposed solutions, and determined the optimal solution . Li Hua et al. (2008), after analysing the current situation of medical waste treatment in China, formulated corresponding strategies for medical waste treatment with respect to treatment methods, such as incineration technology, landfill, etc. Huang et al. (2008) focused on the treatment of medical waste in China. Huang et al. (2008) focused on the collection and transportation of ordinary daily waste, studied in depth the methods and tools used in the waste recycling management system, rationally planned the transportation time and routes, compared the differences between medical waste and daily waste recycling systems, and optimised the location of the recycling system's transfer station facilities. Huang Hongli (2021) based on the social network of urban medical waste recycling network to carry out certain planning, the development process of China's medical waste treatment research, analysis of medical waste destruction process used in the three incineration technology, to determine the different scope of application of the three technologies and energy consumption value, for different types of medical waste treatment technology selection to provide a reference basis. The three incineration technologies are analysed in the development process of medical waste destruction.

(3) Optimisation of pathways for medical waste recycling

In the 1980s, the development of medical diagnostic technology and health care services in many developed countries led to a growing interest in the recycling and disposal of medical waste, and Rutala and Mayhall (1992) summarised the scientific data relating to the disposal of medical waste to point out the shortcomings of the existing regulations and to emphasise the importance of the proper disposal of medical waste. Rutala and Mayhall (1992) summarised scientific data on the disposal of medical waste. Rutala and Mayhall (1992) summarised the scientific data on medical waste disposal and highlighted the importance of proper disposal of medical waste.

With the deepening of the understanding of medical waste, many scholars have studied the collection and transport system for handling medical waste.Ardjmand et al. (2016) proposed a model on the selection and transport of hazardous waste disposal points with the objective of

minimising the total cost of site selection and transport and solved it with an improved genetic algorithm .Tembhurkar and Deshpande (2018) proposed a methodology for the evaluation of medical waste collection and transport systems and optimised the collection and transport routes . Homayouni and Pishvaee (2020) developed a robust optimisation model for minimisation of transport and operational costs and designed a system for collection and disposal of medical waste under uncertainty conditions .

Path optimisation for the recycling process has also been intensively studied by foreign scholars.Hachicha et al. (2014) studied the vehicle routing problem with capacity constraints for the transport of medical waste from 12 hospitals in Tunisia to the treatment centre and analysed it using CPLEX9.0 software. Teoh et al. (2016) A data-driven multi-objective differential evolutionary algorithm to solve the route optimisation problem with safety capacity constraints during medical waste transportation .Alshraideh H and Qdais (2017) proposed a multi-objective vehicle path model, which was shown to be effective in optimising vehicle paths by comparing it with monthly data from a hospital in Turkey· Daoud et al. (2020) investigated the vehicle path problem with stochastic demand and capacity constraints using 16 hospitals in a Tunisian governorate as an example and used a heuristic algorithm to find better results. Faizal et al. (2021) studied the problem of recycling medical waste from a specialist hospital in a city in India with the objective of minimising the transport time and solved it using a particle swarm optimisation algorithm. Eren and Tuzkaya (2021) studied the problem of the safest route for medical waste vehicles with the shortest travelling distance by building a linear programming model in the context of new crowns .

China's research on medical waste recycling started late, but in recent years, domestic scholars have carried out in-depth research in combination with China's relevant standards and practical applications. Wang Lei et al. (2017) discussed the advantages and disadvantages of incineration and autoclave treatment of medical waste, and put forward relevant suggestions to reduce the production of medical waste . Xu Henggang and Wei Xia (2020) sorted out the medical waste management system and treatment process in developed countries, and put forward suggestions for China's emergency management system in the context of the epidemic. Ma Jie et al. Ma Jie et al. (2021) discussed the problems at the present stage according to the relevant data and management policies of medical waste, and gave countermeasures in the light of the new situation of the epidemic. Domestic scholars have also gradually deepened their research on the optimisation of the path of medical waste recycling. He Zhengzang and Liu Sha (2015) He Zhengzang and Liu Sha (2015) established a path optimisation model with the objective of shortest total recycling time of urban medical waste, and used the algorithm of max-min ant colony to solve the problem, and used the example of Jinniu District, Chengdu City to test its effectiveness . Liu Sha (2016) discusses the vehicle path problem of periodic medical waste recycling and establishes the relevant model, and solves it by neighbourhood search based on the idea of genetic algorithm . Pu Song and Xia Chang (2018) constructed a robust optimisation model of medical waste recycling path with time window and changing unit operating cost based on Lagrangian algorithm with the objective of minimising the total cost, and proved its feasibility by examples . Meng Jia (2019) constructed a multi-trip medical waste transport vehicle path optimisation model with a time window by considering the economic, environmental and social benefits, and solved it by CPLEX software . Zhang Xukun (2021) rationally planned the reverse logistics network structure of small and medium-sized cities in China, and established a reverse logistics network model for medical waste with the goal of cost minimisation. Xue, L. Q. and Huang, Y. W. (2021) Xue, Liqiang and Huang, Yaowen (2021) discussed the problems in the management of domestic medical waste and transport routes, and proposed measures to improve the management system and optimise the routes.They proposed measures to improve the management system and optimise the route. Zhao Jiahong et al. (2022) established a medical waste transport site-path model with the objectives of

epidemic risk and cost minimisation, designed a multi-objective optimisation algorithm, and verified its effectiveness with test cases .

3.4. Literature Review

Although scholars at home and abroad have made a lot of achievements in research on the optimisation of collection and transportation systems for domestic waste, due to the special characteristics of medical waste and the suddenness of public health crises, the methods of recycling and transportation of medical waste are not the same as those of domestic waste in some aspects. However, there have been relatively few studies on the improvement of medical waste recycling, and the following problems exist in these limited studies:

(1) In terms of research objects, mainly electronic waste, end-of-life automobiles, home appliances and other industries are more thoroughly researched, and there are fewer studies on the improvement of pathway recycling involving medical waste, while the legal and reasonable treatment of medical waste is an issue to which the state and the government pay more attention at present.

(2) Previous studies on VRP vehicle path optimisation problems have focused on general forward logistics, but the vehicles used in medical waste recycling are non-general trucks with cold chain properties and belong to reverse logistics. According to the different types, scales and fuzzy degrees of the research object, different algorithms can be used to solve the problem, most of which are heuristic algorithms, among which genetic algorithms are more commonly used in the reverse logistics network model solving, but for larger problems because of the limitations of genetic algorithms for local search need to be improved in order to improve the speed and accuracy of the model solving.

References

[1] R. Canan Savaskan, Luk N. van Wassenhove. Closed-Loop Supply Chain Models with Product Remanufacturing [J]. Management Science, 2004, 50(2):239-252.

[2] Huiming Zhang, Aytun Ozturk. How to increase the recovery rate for waste cooking oil-to-biofuel conversion: a comparison of recycling modes in China and Japan[J]. Ecological Indicators, 2015, 146-150.

[3] Zhang F, Dong P, et al. A fuzzy evaluation and seljction of construction and demolition waste utilization modes in Xi'an, China[J]. Waste Management & Research, 2020, 38(7):792-801.

[4] Konstantin Born, Mehmet Metehan Ciftci, The limitations of end-of-life copper recycling and its implications for the circular economy of metals. Resources, Conservation and Recycling, Volume 200, 2023, 0921-3449.

[5] Wu, Y. P.. Research on the selection of packaging waste recycling mode based on EPR [D]. Chongqing University of Technology, 2011.

[6] Cai Key. Pesticide packaging waste recycling: supportive attitude and model selection[J]. Economic and Management Research, 2013(12):67-74.

[7] MA Zujun, HU Shu, Dai Ying. Closed-loop supply chain decision making for electrical and electronic products under government regulation[J]. Industrial Engineering and Management, 2016, 21(01):45-51.

[8] LI Zhengjun, ZHANG Zhen Evaluation study on the selection of enterprise packaging waste recycling mode under the perspective of supply-side structural reform[J]. Ecological Economy, 2019, 35(03):68-72.

[9] Li Deqing, Chen Ying. Research on the selection of chemical waste reverse logistics recycling mode[J]. Science and Industry, 2020, 20(1):145-149.

[10] Zhu Yu. Research on agricultural waste recycling logistics model [D]. Yangzhou University, 2023, 21-34.

[11] Ravi V, Shankar R. Analysis of interact ions among the barriers of reverse logistics[J]. Technological Forecasting & Social Change, 2005, 720(8):1011-1029.

[12] Tiffany M, Iris K. M, Promoting food waste recycling in the commercial and industrial sector by extending the Theory of Planned Behavior: a Hong Kong case study, Journal of Cleaner Production, 2018, 1034-1043.

[13] He L, Yuan H. Investigation of construction waste recycling decisions by considering consumers' quality perceptions[J]. Journal of Cleaner Production, 2020, 259:120928.

[14] Xie J P, Chen R Q. A cost-benefit analysis model of reverse logistics for product recycling and disposal[J]. China Circulation Economy, 2003, 17(1):29-32.

[15] HU Chenxia, HUANG Zuqing, WU Zengyuan. Study on the Cognition and Behavioral Patterns of Enterprises on the Recycling of Waste and Used Electronic Products-Taking Zhejiang Province as an Example[J]. Industrial Technology and Economy, 2010, 29(7):36-39.

[16] Xu Minli, Li Shenglan, Zheng Jie, Research on the cooperative mechanism of e-waste recycling based on evolutionary game in the context of "Internet + recycling"[J]. Operations Research and Management, 2018, 27(09):87-98.

[17] Lin Hongtao. System dynamics (SD) research on the influencing factors of express packaging waste recycling in urban communities [D]. Taiyuan University of Technology, 2018.

[18] Yan Yaling. Research on Pricing Decision Making in Formal and Informal Recycling Channels for E-waste [D]. Nanjing University of Technology, 2022, 28-35.

[19] Cross F L J. Siting a medical waste treatment facility [J]. 1990, 22(9):68

[20] Debita M, Musat C, Mereuta E, et al. Hazardous Private Healthcare Waste Management and Forecast of Medical Waste Generation [J]. Revista de Chimie- Bucharest-Original Edition-, 2017, 68(9):2048-2051.

[21] Mantzaras G, Voudrias E A. An optimization model for collection, haul, transfer, treatment and disposal of infectious medical waste: application to a Greek region[J]. Waste Management, 2017, 25:321.

[22] Xu Henggang, Wei Xia. Research on medical waste treatment issues in the context of the new crown epidemic[J]. China Storage and Transportation, 2020(08):121-122.

[23] Zhang Wenwen. Exploring the problems in medical waste treatment and its solution measures[J]. Low Carbon World, 2016 (18):243-244.

[24] Huang Zhengwen, Zhang Bin, Ai Nanshan, et al. Comparative analysis of eight medical waste treatment methods[J]. Chinese Journal of Sterilization, 2008, 25(003):313-315.

[25] CHEN Wei. Application of medical waste management system based on cloud management--Practical exploration of the First People's Hospital of Yancheng City[J]. Science and Technology Communication, 2020, 12(14):147-149.

[26] Bahar Y Kara, Vedat Verter. Designing a Road Network for Hazardous Materials Transportation[J]. Transportation Science, 2004, 2(38):65.

[27] Aylin Zeren Alagoz, Gunay Kocasoy. Improvement and Modification of the Routing System for the Health-Care Waste Collection and Transportation in Istanbul[J]. Waste Management, 2008, 8(24):1461-1471.

[28] Thu Thuy Thi Nguyen, Anh Quoc Hoang, Vinh Dinh Nguyen etal. Concentrations, Profiles, Emission Inventory, and Risk Assessment of Chlorinated Benzenes in Bottom Ash and Fly Ash of Municipal and Medical Waste Incinerators in Northern Vietnam[J]. Environmental Science and Pollution Research, 2020, 22(77):13340-1335.

[29] Saeed Kargar; Mohammad Mahdi Paydar; Abdul Sattar Safaei. A Reverse Supply Chain for Medical Waste: a Case Study in Babol Healthcare Sector[J]. Waste Management, 2020, 05(113):197-209.

[30] K. Jaya Krishna. Jayakumar; G. Bharathiraja. Mechanical Analysis of Medical Waste Reinforced Polymer Composite[J]. Materials Today: proceedings, 2020, 22(3):473-476.

[31] Yukihiro Ikeda. Estimation of Infectious Medical Waste Quantities on a Perpatient Basis: an Observational Study at a Hospital[J]. The Open Waste Management Journal, 2019, 12(1):1-5.

[32] Liu Rui, Zhang Jiansheng, Wan Qingzhong, Liang Asia. Current situation and countermeasures of medical waste management in village health offices in Banan District, Chongqing[J]. China Health Industry, 2016, 13(33):171-173.

[33] HUANG Liang, ZHANG Dongmei, ZHANG Jirong, ZHAO Jianing, GUAN Juanzhong. Evaluation of medical waste management in primary healthcare organizations in Anhui Province[J]. Journal of Nanjing Medical University (Social Science Edition), 2019, 19(03): 214-217.

[34] Liu B. Research on economic analysis of medical waste management system in Shanghai[J]. Environmental Science and Management, 2018, 43(11):6-9.

[35] Zhang Ying. Research on the status quo and countermeasures of medical waste treatment in northern China[J]. Electronic Journal of Clinical Medicine Literature, 2015, 2(29):6140-6141.

[36] Chang Hong, Tao Hong, Wang Yajuan. Research on the status quo and economic countermeasures of medical waste treatment in Ningxia[J]. Environmental Health Engineering, 2013, 21(05):41-44.

[37] SHI Jing, LI Hanwei. Evaluation analysis of healthcare resource allocation in China-Based on bibliometric analysis in CNKI since 1988[J]. Modern Hospital Management, 2019, 5(17):17-19.

[38] He Zhenggang, Zhang Faming. Construction of medical waste logistics network evolution model based on system dynamics[J]. Journal of Transportation Engineering and Information, 2016, 4(14):18-23.

[39] Zhao Shuairan, Li Na. Analysis of the current situation of medical resources allocation and countermeasures in Beijing[J]. China Health Industry, 2018, 22(027):27-28.

[40] Li Yang. Research on reverse logistics network for regionalized treatment of medical waste in Liaoning Province [D]. Dalian: Dalian Maritime University, 2015: 12-30.

[41] Li Yue, Chen Yang, Wu Anhua, et al. Discussion on the technology and management mode of medical waste disposal in remote areas of China[J]. Chinese Journal of Infection Control, 2019, 18(01):89-94.

[42] HUO Qingqing, GUO Sound. Optimization of multi-objective multi-cycle sustainable recycling network for medical waste[J]. Journal of Shanghai University of Technology, 2020, 42(198):67-75.

[43] FANG Shuqi, CUI Junle, BAI Jing, et al. A review of medical solid waste treatment technologies[J]. Applied Chemical Engineering, 2019, 48(011):2677-2687.

[44] Zhao JW. Research on fuzzy positioning-path-inventory problem in medical waste recycling [D]. Chengdu: Southwest Jiaotong University, 2010: 14-33.

[45] Li H, Xu J, Pan MQ, et al. Current situation of treatment technology and disposal of solid medical waste in China[J]. Journal of Hebei North College, 2008, 25(3):72-74.

[46] HUANG Xi, ZHAO Yucai. Progress of Solid Waste Implementation and Implications for China[J]. Nonferrous Metallurgy Design and Research, 2008, 29(01):34-36.

[47] Huang Hongli. Research on urban medical waste recycling network planning based on social network [D]. Yanshan University.

[48] Rutala W A, Mayhall C G. Medical waste[J]. Infection Control & Hospital Epidemiology, 1992, 13(1):38-48.

[49] Ardjmand E, Young II W A, Weckman G R, et al. Applying genetic algorithm to a new bi-objective stochastic model for transportation, location, and allocation of hazardous materials[J]. Expert systems with applications, 2016, 51:49-58.

[50] Tembhurkar A R, Deshpande R. Scenario-based risk assessment model for infectious medical waste collection and transportation system[J]. International Journal of Risk Assessment and Management, 2018, 21(4):271-282.

[51] Homayouni Z, Pishvaee M S. A bi-objective robust optimization model for hazardous hospital waste collection and disposal network design problem[J]. Journal of Material Cycles and Waste Management, 2020, 22(6):1965-1984.

[52] Hachicha W, Mellouli M, Khemakhem M, et al. Routing system for infectious healthcare-waste transportation in Tunisia: a case study[J]. Environmental engineering and management journal, 2014, 13(1):21-29.

[53] Teoh B E, Ponnambalam S G, Subramanian N . Data driven safe vehicle differential evolution algorithm to reduce Co2 emissions and hazardous risks[J]. Annals of Operations Research, 2016, 270(1):1-24.

[54] Alshraideh H, Qdais H A. Stochastic modeling and optimization of medical waste collection in Northern Jordan[J]. Journal of Material Cycles and Waste Management, 2017, 19(2):743-753.

[55] Daoud R, Kammoun M, Hachicha W. Solving a routing problem of collecting infectioushealthcare waste with stochastic demand: case of Sfax Governorate in Tunisia[J]. World Review of Intermodal Transportation Research, 2020, 9(3):297-311.

[56] Faizal U M, Jayachitra R, Vijayakumar P, et al. Optimization of inbound vehicle routes in the collection of bio-medical wastes[J]. Materials Today: proceedings, 2021.

[57] Eren E, Tuzkaya U R. Safe distance-based vehicle routing problem: Medical waste collection case study in COVID-19 pandemic[J]. Computers & Industrial Engineering, 2021, 157:107328.

[58] Wang Lei, Zhao Na, Wang Binsong, Yuan Chen, Xing Zipeng, Liu Yang, Zheng Shengliang. A preliminary study on the environmental impact of medical waste management[J]. Environmental Science and Management, 2017, 42(08):10-13.

[59] Xu Henggang, Wei Xia. Research on medical waste treatment problems in the context of the new crown epidemic[J]. China Storage and Transportation, 2020(08):121-122.

[60] MA Jie, ZHANG Cheng, ZHANG Aiguo, ZHANG Houhu. Research on the current situation of medical waste management and system improvement in China[J]. Journal of Ecology and Rural Environment, 2021, 37(08):953-961.

[61] HE Zhengzang, LIU Sha. Research on the optimization of urban medical waste recycling path--Taking Jinniu District, Chengdu City as an example[J]. Logistics Technology, 2015, 34(01):117-119.

[62] Liu Sha. Research on the optimization problem of medical waste recycling network under periodic recycling strategy [D]. Chengdu: Southwest Jiaotong University, 2016.

[63] Pu S, Xia Sheung. Robust optimization model of urban medical waste recycling path[J]. Systems Engineering, 2018, 36(06):117-123.

[64] Meng Jia. Research on path optimization of medical waste transportation vehicles based on third-party logistics and distribution [D]. Beijing: Beijing University of Chemical Technology, 2019.

[65] Zhang XK. Research on the design of medical waste reverse logistics network in small and medium-sized cities [D]. Tianjin: Tianjin University of Technology, 2021.

[66] Xue LQ, Huang YW. Research on medical waste management system and optimization path [J]. China Medical Management Science, 2021, 11(05): 28-33.

[67] Zhao Jiahong, Huang Shuyuan, Chen Zhiwei et al. Site selection-path optimization for medical waste transportation under epidemic risk prevention and control[J]. Transportation Science and Economy, 2022, 24(06):1-8.