Study on the Green Development Channels of Logistics Enterprises in E-Commerce Environment

Tingting Jiang and Yahong Sun(✉)

School of Economics and Management, Shanghai Institute of Technology, Shanghai 200235, China
sunyahong97@163.com

Abstract. The rapid development of Internet technology has not only promoted the continuous reform of e-commerce, but also promoted the development of the logistics industry. More and more consumers are inclined to do online shopping, which improves the economic and social benefits of e-commerce. Under the background of carbon neutralization and carbon peak, it also puts forward new requirements for the coordinated development of e-commerce and logistics enterprises. Therefore, based on the development dilemma of logistics enterprises under the background of e-commerce, this paper established a system dynamics (SD) model based on the coordinated development of e-commerce and logistics enterprises and made a simulation analysis. It puts forward countermeasures and suggestions for the green development of logistics enterprises under the environment of e-commerce, and provides references for promoting the green development of the industry.

Keywords: E-commerce · logistics enterprises · development channels · system dynamics

1 Introduction

As of June 2021, the number of online shopping users in China has reached 812 million. In the first half of 2021, the national online retail volume was 6113.3 billion RMB, of which the online retail volume of physical goods was 5026.3 billion RMB [3]. As important support to promote the development of the e-commerce industry, logistics enterprises completed 108.3 billion express businesses in China in 2021, accounting for more than half of the global express volume, ranking first in the world for eight consecutive years. It will continue to grow in the next few years. With the rapid development of the economy, people have exposed the problems of excessive packaging affecting the environment in the development of e-commerce and logistics enterprises. Therefore, China has issued 'the opinions on promoting the coordinated development of e-commerce and express logistics'. It is emphasized to promote green packaging, explore packaging recycling and establish a multi-party collaborative recycling system among packaging producers,

Z. Zeng et al. (Eds.): ECIT 2022, AHE 11, pp. 326–336, 2023.
https://doi.org/10.2991/978-94-6463-005-3_32

users and consumers [6]. It can effectively reduce the carbon emissions brought by e-commerce and logistics enterprises, and promote the green coordination and sustainable development of e-commerce and logistics enterprises.

Many experts and scholars have studied the recycling of packaging. Andreasi Bassi et al. [1] selected 40 management schemes for the plastic packaging waste produced by families and found that maximizing the recovery rate and reducing the processing loss can achieve environmental benefits. Dahlbo et al. [4] assessed the resource potential of separate recycling or mixed with municipal solid waste. It was pointed out that the quantity and quality of packaging materials have a great impact on the recycling potential. Jang et al. [7] analyzed the material flow of plastic packaging through life cycle assessment and pointed out that improper disposal ways of packaging waste will pose a threat to the marine environment. Wang et al. [13] analyzed the impact of government policies on recyclers' willingness to participate in plastic recycling through the evolutionary game model. The results showed that recyclers are more sensitive to government punishment measures. The research on plastic packaging recycling has attracted the attention of academia. It can be seen that there is less literature on packaging recycling based on system dynamics (SD), and there are even fewer studies on e-commerce packaging recycling based on SD. Based on the development of e-commerce, the proportion of e-commerce packaging waste in domestic waste is increasing, so it will produce serious environmental pollution and threaten human health [5]. The recycling of e-commerce packaging is of great significance to alleviate environmental pressure, waste of resources, and save materials.

Therefore, this paper used the system dynamics model to simulate and optimize the carbon emissions of E-commerce package recycling modes under different policy backgrounds, to provide suggestions for promoting the green coordination and sustainable development of e-commerce and logistics enterprises.

2 SD Model of Green Development of E-Commerce and Logistics Enterprises

2.1 System Boundary and Assumption

This study mainly analyzed the green development potential of e-commerce and logistics enterprises under different scenarios, i.e., under the situation that the government does not take measures, the e-commerce platform reduces packaging, the government supervises and encourages logistics enterprises, and improves the perfection of the recycling system. The green development of logistics enterprises under the e-commerce environment is simulated and analyzed. This paper mainly judges the degree of green development of e-commerce and logistics enterprises through CO_2 emissions under different policy backgrounds. In this system, we mainly take e-commerce plastic packaging as an example, because only about 2% of e-commerce plastic packaging in China is recycled, and the rest are disposed of together with domestic waste [11], which has a significant impact on the green development of e-commerce and logistics enterprises. E-commerce plastic packaging refers to plastic bags, woven bags, air bubble bags, tape and their mixtures. The conceptual framework of the model is shown in Fig. 1. The model is based on the

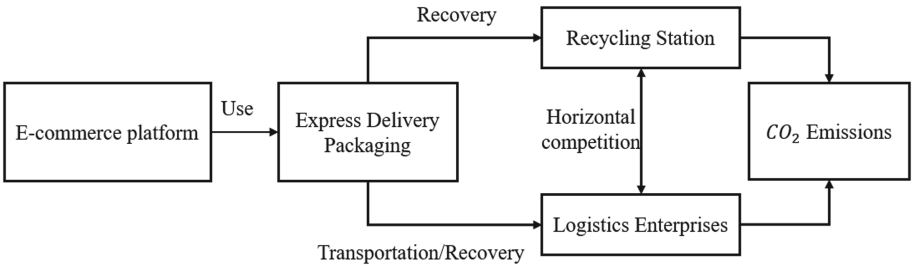

Fig. 1. The conceptual framework of the model.

following settings: initial time = 2020, final time = 2030, time step = 1, unit of time = year. The data are mainly from the State Post Bureau of China, the National Bureau of Statistics, Ecoinvent and CSMAR. There are many factors affecting the e-commerce packaging recycling system, so it is necessary to introduce some assumptions. The SD model is based on the following assumptions:

Assumption 1: Only logistics enterprises and garbage recyclers participate in the end-of-life stage of e-commerce packaging. After recycling, logistics enterprises carry out secondary processing and garbage recyclers bury or burn plastic packaging waste with municipal solid waste.

Assumption 2: Only the CO_2 emissions from the disposal of e-commerce packaging waste are considered, and the CO_2 emissions from transportation are not considered.

Assumption 3: The recycling capacity of logistics enterprises and garbage recyclers is unlimited.

Assumption 4: According to the results of the seventh population census, the population of China has increased by 72.06 million compared with 2010, an increase of 5.38% and an average annual growth rate of 0.53% (NBSPRC 2020). This paper assumes that the population of China will continue to grow at 0.53%.

2.2 Main Parameters and Equations

The SD flow diagram green development of e-commerce logistics enterprises is shown in Fig. 2. The CO_2 emissions from recycling, incineration and landfill of e-commerce packaging waste can be described and assigned according to IPCC (2016), Wang and You [12] and [14]. Because the weight reflects the importance of each factor in the system, it is directly related to the contribution rate of each factor to the system [8]. It evaluated the influencing factors of logistics enterprises participating in e-commerce plastic packaging according to the research of Lin (2018). Model equations settings and variable descriptions are shown in Appendix Table 1.

2.3 Model Validation

2.3.1 Dimensional Consistency Test

On the premise of ensuring that the dimensions have practical significance, the SD model should ensure that the dimensions in the equation are consistent. In this paper,

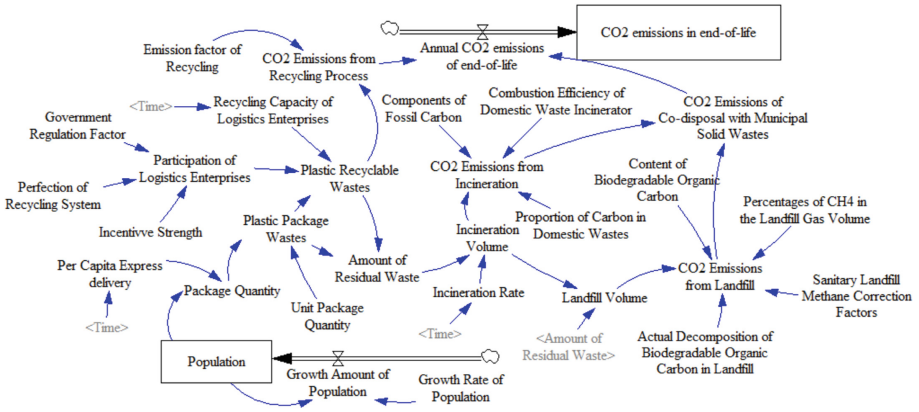

Fig. 2. The SD flow diagram green development of e-commerce logistics enterprises

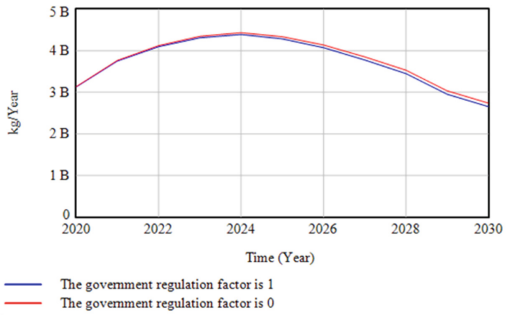

Fig. 3. The landfill volume of e-commerce packaging under different government supervision

the dimensional consistency test is carried out by using the dimension test function of Vensim PLE software. The dimensional consistency test results show that the dimensions of variables are consistent and pass the dimensional consistency test.

2.3.2 Extreme Conditions Test

Assume that the government regulation is 0 and 1 for the limit test. If the government supervision is strong, the possibility of logistics enterprises participating in e-commerce packaging recycling will increase. The recycling volume of e-commerce packaging will increase, and the landfill volume will decrease. If government supervision is low, logistics enterprises are less likely to participate in e-commerce packaging recycling. The recycling amount is reduced and the landfill amount is increased. The simulation results are shown in Fig. 3. The results showed that the government supervision has passed the limit test. After many extreme tests, the variables in the model were all fine. Therefore, the model passed the extreme conditions test.

3 Scenario Simulation Results and Simulation Analysis

3.1 Without Taking Any Measures

In the initial situation, according to the simulation results of the SD model, we can get the CO_2 emissions based on the green development model of e-commerce and logistics enterprises without taking any measures. Without taking any measures, the cumulative CO_2 emissions of e-commerce plastic packaging in China will reach about 42 Billion $kgCO_2e$ from 2020 to 2030, which will not be conducive to China's goal of carbon peak and carbon neutralization. Through the specific analysis of the CO_2 emissions of the green development model of e-commerce and logistics enterprises, it can be obtained landfill and incineration are the two main ways to dispose of e-commerce packaging waste, in which the CO_2 emissions generated by incineration accounts for more than 80%.

3.2 Implementation of Packaging Reduction in E-Commerce Enterprises

Excessive packaging of e-commerce is one of the most prominent problems in China. In the measures for the administration of postal express packaging issued by the State Post Office, it is emphasized that the delivery enterprises should in accordance with the principles of environmental protection and economy, minimize the number of packaging layers, voids and fillers. The excessive packaging of the e-commerce packages not only wastes resources, but also pollutes the environment. Therefore, this paper takes the packaging reduction degree of the e-commerce platform as a variable to discuss its impact on the green development of e-commerce and logistics enterprises. Setting the packaging reduction degree of e-commerce platform to 0.1, 0.3 and 0.5 respectively can obtain the CO_2 emission results as shown in Fig. 5. Through the simulation results, it can be found that the key to promoting the green development of e-commerce enterprises and logistics enterprises is to control from the source (Fig. 4).

3.3 Under Different Government Regulation

At present, China has no effective regulatory measures for the recycling of e-commerce packaging, mostly normative documents, which is difficult to effectively promote the recycling of e-commerce plastic packaging. Therefore, this paper takes government supervision as an external variable to discuss the impact of different supervision on the green development of e-commerce and logistics enterprises. By increasing the factor of government regulation by 25%, i.e. the government regulation coefficients are 0, 0.25, 0.5 and 0.75 respectively, the simulation results of CO_2 emissions of the e-commerce packaging recycling system as shown in Fig. 6 can be obtained.

From the simulation results, government regulation has a positive impact on logistics enterprises' participation in e-commerce packaging recycling, that is, when the government increases the supervision of logistics enterprises, it will reduce the environmental impact of e-commerce plastic packaging. However, from the simulation results, the impact of government regulation on CO_2 emission reduction is not obvious, reducing 0.04 Billion $kgCO_2e$, 0.09 Billion $kgCO_2e$ and 0.13 Billion $kgCO_2e$ respectively. When

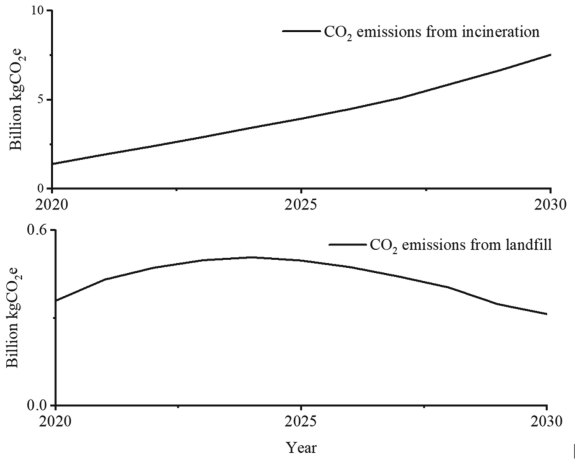

Fig. 4. CO_2 emissions from incineration and landfill

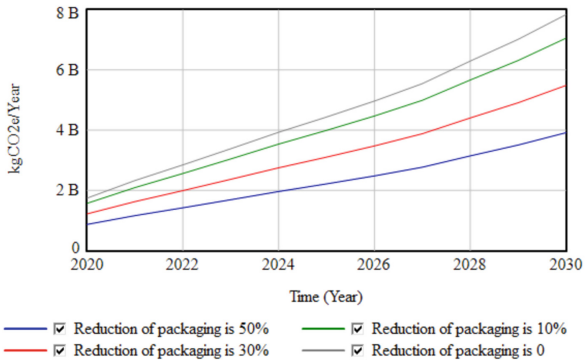

Fig. 5. CO_2 emissions under different packaging reduction in e-commerce enterprises

the government regulation coefficient is 0.75, the cumulative CO_2 emission reduction is 0.361 Billion $kgCO_2e$. The main reason is that government regulation is an institution in which the government regulates and restricts relevant enterprises in order to reduce the environmental harm caused by e-commerce packaging waste. Under this institution, it will not alleviate the cost pressure caused by logistics enterprises participating in e-commerce packaging recycling. And the enthusiasm of logistics enterprises participating in recycling has not been significantly improved.

3.4 Under Different Perfection of Recycling System

The environmental pollution brought by e-commerce packaging in China has become the fourth largest pollution source after water pollution, marine and lake pollution and air pollution [15]. However, the e-commerce packaging recycling system in China is not perfect. Most logistics companies and consumers do not reuse e-commerce packaging

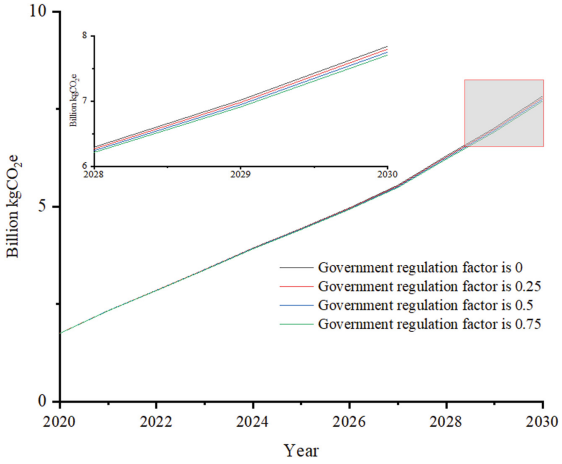

Fig. 6. CO_2 emissions under different government regulation

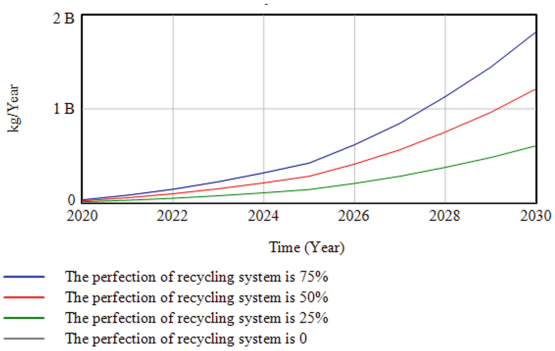

Fig. 7. CO_2 emissions under different perfection of recycling system

and mix it with domestic waste. Therefore, considering the impact of the perfection of the e-commerce packaging recycling system on the enthusiasm of logistics enterprises to participate in packaging recycling, this paper obtains its impact on the green development of e-commerce and logistics enterprises through simulation. By increasing the recovery system improvement coefficient by 25%, that is, the recovery system improvement coefficient is 0, 0.25, 0.5, 0.75 and 1 respectively, we can get the impact of the improvement degree of the recovery system on the green development of e-commerce and logistics enterprises as shown in Fig. 7.

From the output results, improving the recycling system is conducive to improving the recycling amount of e-commerce plastic packaging waste and reducing environmental hazards, so as to improve the green development degree of e-commerce and logistics enterprises. Based on the per capita volume of 91 express deliveries in China in 2022, with the improvement of the recycling system from 0 to 0.75, the annual CO_2 emissions of the e-commerce packaging recycling system is reduced from 1.74822 Billion $kgCO_2e$

to 1.74378 Billion kgCO_2e, a decrease of 0.25%. According to the measurement data of per capita express delivery in China, it is estimated that from 2020 to 2030, the perfection of the recycling system will be from 0 to 0.75, and the cumulative CO_2 emissions at the end-of-life of e-commerce packaging will be reduced from 44.0279 Billion kgCO_2e to 43.0992 Billion kgCO_2e, reducing about 0.93 Billion kgCO_2e. The saved CO_2 emissions is slightly higher than that generated by agriculture, forestry, animal husbandry, fishery and water conservancy in Shanghai in 2019 [2], Therefore, improving the CO_2 emissions of e-commerce plastic packaging in China, improving the recovery rate and strengthening the secondary use of e-commerce packaging waste are of great significance to promote the green development of e-commerce and logistics enterprises.

3.5 Under Different Economic Incentives

Generally speaking, incentive refers to the means to achieve a certain purpose of the government through incentives and other ways. The essential purpose is to guide individuals to actively participate, which is different from government supervision. The government's economic incentive policy is considered to be one of the most effective policies. The government uses the incentive policy to make logistics enterprises adopt various recycling methods. Guiding the incentive for logistics enterprises may affect the decision of logistics enterprises to participate in the recycling of express plastic packaging. Therefore, considering the impact of government economic incentives on the CO_2 emissions of the e-commerce package recycling system, this paper sets the government economic incentive coefficient as 0, 0.25, 0.5, 0.75 and 1 respectively, and analyzes its impact effect.

Figure 8 shows the impact of government economic incentive policies on the green development of the e-commerce and logistics enterprises. From the simulation results, the government incentive policy has a positive impact on CO_2 emission reduction. At the initial stage of the government implementation of the economic incentive policy, it has little impact on the CO_2 emission reduction effect of e-commerce packaging recycling system. The CO_2 emissions will be reduced by 0.14 Billion kgCO_2e from 2020 to 2025. Over time, the effect of government economic incentive policy began to appear. In 2030, when the government economic incentive policy coefficient is 0.75, the CO_2

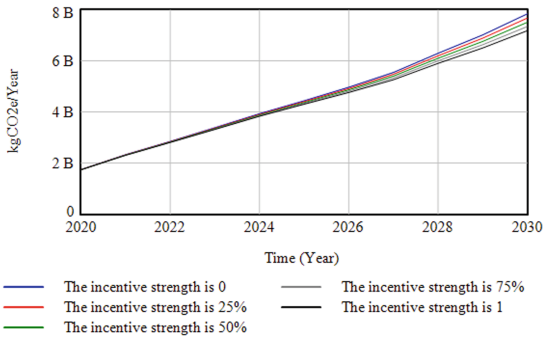

Fig. 8. CO_2 emissions under different economic incentives

emissions of the rapid plastic packaging recycling system will be reached 7.34639 Billion $kgCO_2e$, which is 0.494 Billion $kgCO_2e$ lower than that without economic incentive policy, with a cumulative decrease of 1.327 Billion $kgCO_2e$. In view of the difficulty of e-commerce plastic packaging recycling and high sorting degree, relevant incentive mechanisms should be set up to support and reward logistics enterprises participating in e-commerce plastic packaging recycling, and encourage enterprises to participate in packaging recycling more, to improve the green degree of e-commerce and logistics enterprises.

4 Conclusions

Through the simulation analysis, the reduction of packaging volume by e-commerce enterprises, government supervision, economic incentives and the perfection of recycling system can reduce the CO_2 emission of e-commerce plastic packaging recycling system to varying degrees. When the government does not take any measures, the cumulative CO_2 emissions of China's e-commerce packaging disposal system will reach 42 Billion $kgCO_2e$ from 2020 to 2030, of which incineration accounts for more than 80%. When the government regulation coefficient, economic incentive coefficient and the perfection of the recycling system increase from 0 to 0.75 respectively, the CO_2 emissions of China's e-commerce packaging recycling system can be reduced by 0.361 Billion $kgCO_2e$, 1.327 Billion $kgCO_2e$ and 0.929 Billion $kgCO_2e$ respectively. It can be seen that the economic incentive policy is the most effective. In addition, when e-commerce enterprises implement the packaging reduction policy, it has the greatest impact on promoting the green development of e-commerce and logistics enterprises.

With the rapid development of e-commerce and logistics, various e-commerce packages emerge one after another, resulting in serious resource waste and environmental pollution. Therefore, to promote the green development of e-commerce and logistics enterprises: Firstly, e-commerce enterprises as the source should standardize packaging, simplify packaging, and use less fillers. Secondly, as a logistics enterprise, it should establish a unified recycling mechanism, open door-to-door recycling services, and improve the secondary use frequency of packaging. Thirdly, as a government, it should establish a sound recycling mechanism, improve relevant laws and regulations, clearly stipulate China's e-commerce packaging recycling standards. In addition, it should imply incentive policies, encourage relevant enterprises to participate in packaging recycling, improve the recycling rate and remanufacturing proportion of packaging waste, and improve the green level of e-commerce development.

Appendix

Table 1. The main parameters and equations of express plastic packaging recycling system

Variables	Unit	Equation and parameters
Components of Fossil Carbon	Dmnl	0.39
Combustion Efficiency of Domestic Waste Incinerator	Dmnl	0.95
Proportion of Carbon in Domestic Wastes	$kgCO_2e/kg$	0.2
Content of Biodegradable Organic Carbon	Dmnl	0.125
Percentages of CH4 in the Landfill Gas Volume	Dmnl	0.5
Sanitary Landfill Methane Correction Factors	$kgCO_2e/kg$	1
Growth Rate of Population	Dmnl	0.0053
Incineration Rate	Dmnl	WITHLOOK UP(Time) ([(0,0)-(3000,10)],(2020,0.62),(2021,0.65),(2022,0.68),(2023,0.71),(2024, 0.74),(2025,0.77),(2026,0.8),(2027,0.83),(2028,0.86),(2029,0.89),(2030,0.91))
Per Capita Express delivery	Dmnl	WITHLOOK UP(Time) ([(0,0)-(3000,300)],(2020,59),(2021,77),(2022,91),(2023,105),(2024,118), (2025,130),(2026,143),(2027,157),(2028,173),(2029,190),(2030,209))
Plastic Recyclable Wastes	kg/Year	Participation of Logistics Enterprises*Recycling Capacity of Logistics Enterprises*Plastic Package Wastes
CEs of Co-disposal with Municipal Solid Wastes	$kgCO_2e/Year$	Carbon Emissions from Incineration + Carbon Emissions from Landfill

References

1. Andreasi Bassi S, Boldrin A, Faraca G, Astrup TF (2020) Extended producer responsibility: how to unlock the environmental and economic potential of plastic packaging waste? Resour Conserv Recycl 162
2. CEADs (2021) China CO_2 Inventory 1997-2019 (IPCC Sectoral Emissions)
3. CNNIC (2021) The 48th statistical report on China's Internet development
4. Dahlbo H, Poliakova V, Myllari V, Sahimaa O, Anderson R (2018) Recycling potential of post-consumer plastic packaging waste in Finland. Waste Manag 71:52–61
5. Fan W, Xu M, Dong X, Wei H (2017) Considerable environmental impact of the rapid development of China's express delivery industry. Resour Conserv Recycl 126:174–176
6. GOTC (2018) The opinions on promoting the coordinated development of e-commerce and express logistics
7. Jang Y-C, Lee G, Kwon Y, Lim J-h, Jeong J-h (2020) Recycling and management practices of plastic packaging waste towards a circular economy in South Korea. Resour Conserv Recycl 158
8. Chunfa L, Nannan X, Xuemin W, Xixi L (2019) Factors influencing the "Internet+" mobile phone recycling mode: theoretical model construction and SD simulation analysis. Complex Syst Complex Sci 16(04):44–55
9. Lin H (2018) Research on system dynamics (SD) about influential factors of express packaging wastes recycling in urban community
10. NBSPRC (2020) Bulletin of the seventh national census
11. Su Y, Duan H, Wang Z, Song G, Kang P, Chen D (2020) Characterizing the environmental impact of packaging materials for express delivery via life cycle assessment. J Cleaner Prod 274
12. Wang W-j, You X-y (2021) Benefits analysis of classification of municipal solid waste based on system dynamics. J Cleaner Prod 279
13. Wang Y, Chang X, Chen Z, Zhong Y, Fan T (2014) Impact of subsidy policies on recycling and remanufacturing using system dynamics methodology: a case of auto parts in China. J Clean Prod 74:161–171
14. Wang Z, Geng L (2015) Carbon emissions calculation from municipal solid waste and the influencing factors analysis in China. J Clean Prod 104:177–184
15. Xiao Z, Yuqin L (2016) Construction of express packaging recycling system based on theory of circular economy. Packag J 8:60–66