

Recycling Model Selection based for express package base on AHP: A practical case of Yunnan University

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Abstract

This research aims to select an optimal recycling mode of express package and provide suggestion for Yunnan University. There are two recycling methods in the campus; Cainiao courier station and campus garbage sorting recycling mode. Then, two major factors were derived through literature reviews which comprises of subjective factor and objective factor. Subjective factors compose of consumer recycling awareness and convenience of packaging recycling. Moreover, factors concern with objective factors are recovery cost, unified packaging standard, incentive policies, recycling channels, and intelligent management of packaging recycling. After extracting all the factors, the interview questions were designed based on Analytical Hierarchy Process (AHP) and interviewed experts for rating the score. The pairwise comparison was computed given the result of Cainiao courier station recycling mode (0.83) and campus garbage sorting (0.15). The result shown that Cainiao courier station recycling mode is the best candidate for recycling method in the campus. In addition, weight of all factors are recycling awareness (0.39), incentive policies (0.14), Convenience of packaging recycling (0.19), recovery cost (0.12), unified packaging standard (0.04), recycling channels (0.09) and intelligent management of packaging recycling (0.03), respectively.

Keywords

Reverse Logistics, Express Packages, AHP

1. Introduction

As the main force of online shopping, college students' shopping ability should not be underestimated. As a social group with tens of thousands of people, colleges and universities have a huge amount of express delivery. In 2018, the number of college parcels in mainland China increased to nearly 2.5 billion in 2018 and expected to exceed 3 billion (Wang and Rao, 2017). Students in Yunnan University has around 25,000. At the campus, around 4,000 to 6,000 packages were arrived at the campus every day. More than 10,000 packages were arrived on the Double 11 shopping day. According to the increasing number of packages, the campus faces with two major problems. Students are lack of awareness for recycling packages and the campus is lack of package recycling management. As a result of these problems, the large number of packages are discarded. This leads to the following problems: resource waste, increasing of the waste disposal cost, environmental pollution.

In recent years, many domestic universities have implemented recycling measures for recycling packaging effectively. There are two packaging recycling methods in Yunnan University. The first method is performed by Cainiao Courier Station (a third-party terminal logistics service platform), and the other is performed through campus garbage sorting. In the campus, Cainiao Courier Station is mainly used to recycle reusable express packages with little damage, such as paper boxes. When students take out the parcel from Cainiao Station, they can directly take out the goods and place the package in the designated recycling area. The rest were handled by Logistics department of Yunnan University. The campus garbage will be sorted by this department. The rubbish bins are classified according to three categories: recyclable, non-recyclable, kitchen waste and hazardous waste. Both recycling methods have been implemented since the second half of 2020 and are currently in the trial phase.

Unfortunately, these two methods are still new to the campus and lack of alignment. The campus faces with a large number of express packages dumped in the garbage site. Causing the package to lose its value. This paper aims to analyse the current situation of package recycling method in the campus. Extracting the factors which effect the

efficiency of campus recycling method. Finally, analytical hierarchy process (AHP) was applied to select the best candidate for package recycling method in Yunnan university.

The instruction of this paper is described as follows section 1 will introduce the problem and the current situation of package recycling method. Section 2 will be the literature of this research and following with methodology on section 3. Then, result and discussion will be described in section 4. The last section is conclusion and limitation of this research shown in section 5.

2. Literature Review

2.1 The related concepts of packaging and packaging recycle

The meaning of packaging is a dynamic concept extending with the development of social economy and technology. Broadly speaking, all the external forms of things with commercial value entering the circulation field are packaging (Zhang, 2018). In China's latest national standard "Logistics Terms" (GB/T 18354-2006), packaging is defined as the general name of containers, materials and auxiliary materials adopted according to certain technical methods to protect products, facilitate storage and transportation, and promote sales in the process of circulation. It also refers to the operation of applying certain technical methods in the process of using containers, materials, and auxiliary materials to achieve the above purposes. When the packaging is separated from its packaging commodities, it will cause packaging waste. Recycling and reuse of packaging waste can avoid environmental pollution. According to the recycling methods of packaging waste, it can be divided into reuse and recycling (Qian, 2019).

1) Reuse is defined as the simple cleaning, inspection and testing of packaging waste without changing its original form and function, and then reusing it for the items before packaging

2) Circulation and Regeneration is the methods of recycling can be divided into two types: primary recycling and secondary recycling. The primary recycling refers to that when the packaging is recycled, the recycling enterprise uses different technologies to re-produce the same new packaging as the original packaging, such as plastic and paper products. Secondary recycling refers to the use of discarded packaging as one of the raw materials when producing new items different from the original packaging type.

Therefore, express package is an essential material for the express industry to provide express services. Its main function is to protect express goods from damage during transportation. When consumers sign for express delivery, express package has completed its own packaging value. If the package is discarded, it will become garbage of express package and pollute the environment. If it is effectively recycled and reused, it will help reduce the environmental pollution of express package. The recycling of express package can be divided into two categories: reuse and circulation and regeneration.

2.2 China express industry and express package development status

In recent years, China's express delivery industry has developed rapidly. In 2020, the total business volume of express delivery service enterprises in China reached 83.36 billion pieces, which accounted for 31.2 percent increased on each year. State Post Bureau of The People's Republic of China (2020) stated that the consumption of various package materials for express delivery in China has increased from 20,600 tons in 2000 to 9,412,300 tons in 2018. If effective measures are not implemented to control it, according to the current development trend of express industry, the consumption of express packaging materials in China will reach 41.27,500 tons in 2025, which will bring huge burden on resources and environmental pressure.

2.3 Factors of package recycling

China's express package recycling situation is developing gradually. China needs to deal with a huge package waste. This may result in the development of reverse logistics in express package is slow and difficult to implement. Most express packaging boxes are discarded by consumers at will without classification, and the effective recovery rate of packaging is less than 10% (China Reports, 2020). This paper extracts factors which may affect the improvement of package recycling method in China from literature review as illustrate in Table 1. Factors can be divided into two major categories: subjective and objective factors with seven sub-factors.

2.3.1 Subjective factors

There are two sub-factors in this category: consumers lack awareness and ease of package recycling.

Recycling awareness

Consumers are unaware of recycling method and green logistics due to the lack of supportive from government. Most urban residents are not aware of the recycling value of discarded express packages, and most organizations engaged in packaging recycling are non-governmental organizations or private recycling enterprises.

Table 1. The Factors and sources of packaging recycling

No.	Journal	recycling awareness	Lack of incentive policies	Convenience of packaging recycling	High recovery cost	Unified packaging standard	Recycling channels	Intelligent management
1	Qiu et al. (2020)	●				●	●	
2	Li et al. (2020)		●					
3	Robinson and Read (2005)	●	●					
4	Wang et al. (2013)	●	●		●			●
5	Vining and Ebreo (1990)			●				
6	Gang (2005)			●				
7	Sander et al. (2007)			●				
8	Guo and Bi (2020)	●	●		●			
9	Liang (2017)	●				●		
10	Wang et al. (2020)	●				●	●	
11	Wang et al. (2018)	●	●			●		●

Convenience

Liao (2017) found that people's recycling willingness and recycling behaviour are affected by the ease of recycling process. People prefer to recycle where the operation process is easy, and the recycling distance is short.

2.3.2 Objective factors

There are five sub-factors in this category: Lack of unified package recycling standard, lack of formal recycling channel, lack of management, lack of incentive policies, and high recovery cost.

Unified package recycling standard

Many e-commerce shops grow rapidly and blindly ignored waste generated from express packages. As a result, express company began to increase gradually. Each company has different style of packing and material. This cause China to face with lack of unified package recycling standard (Wang and Zhu, 2020).

Recycling channel

Although the Chinese government supports and encourages the recycling of packaging waste, the construction of the recycling system has just begun, and how to efficiently recycle packaging waste is only in the exploration and trial stage. Most cities in China do not provide reasonable and effective packaging recycling services. A large-scale and classified recycling system has not been established (Wang et al., 2018).

Intelligent management

Information flow of package recycling process is relatively independent. All departments only pay attention to the continuous transmission of information to the next process without evaluating the effective feedback to the previous one (Li et al., 2020).

Lack of incentive policies

The perspective of residents, although garbage cans in most cities are clearly marked with classifications. Residents still throw away the packages at will after receiving the express. Li et al. (2020), Robinson et al. (2005), and Wang et al. (2018) put forward incentive or penalty policies and preferential tax policies, which are of great significance in improving people's participation in recycling and reducing enterprises' recycling costs.

Recovery cost

Guo and Bi (2020) believe that cost is an important reason for the difficulty in packaging recycling. The first is the logistics cost, whether the enterprise self-logistics or with the help of third-party logistics company cooperation could not avoid with a large amount of costs. In addition, China's current recycling and processing technology is still

underdeveloped, and the level of mechanization is not high, which increases the processing cost of recycling packaging.

3. Methodology

This research methodology can be divided into three parts: problem description, data collection strategy and data analysis strategy. The descriptions are provided as follows.

3.1 *Problem description* explained the problem of packaging recycling in Yunnan University.

3.2 *Data collection strategy* is about how to collect data for this research. The research scope will be defined firstly. Secondly, we designed the questionnaire. The questionnaire will be evaluated by experts in the campus using AHP method.

3.3 *AHP Pairwise comparison* will be computed to find the best candidate for package recycling method in Yunnan University. Finally, results and discussion will be described.

Model design and calculation

The AHP model of packaging recycling mode is shown in Figure 1. Factors and sub-factors are described in section 2. The package recycling mode are C1 (Cainiao) and C2 (Campus)

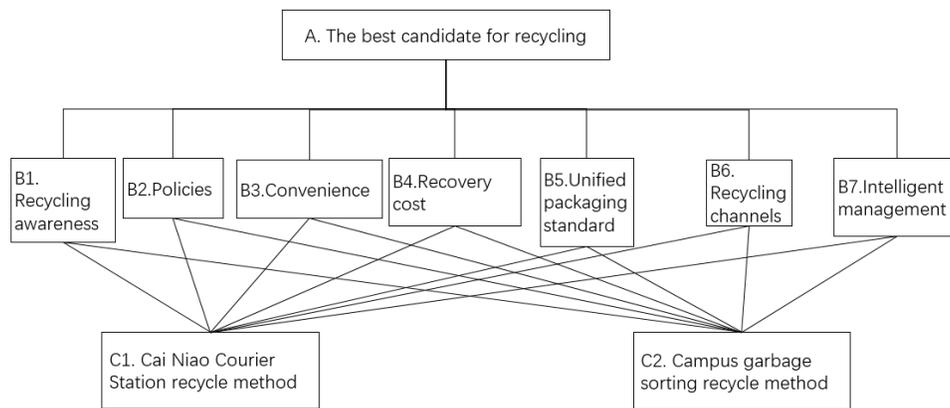


Figure 1. AHP model of packaging recycling mode

Factor weight priorities and consistency

The AHP is computed by using this follow equation

$$\omega_i = \frac{1}{n} \sum_{j=1}^n \frac{a_{ij}}{\sum_{k=1}^n a_{kj}} \quad (1)$$

Where $W = (\omega_1, \omega_2, \dots, \omega_n)^T$

Following with the consistency test with the follow equation

$$\lambda_{max} = \sum_{i=1}^n \frac{(BW)_i}{w_i} \quad (2)$$

$$CI = \frac{(\lambda - n)}{(n-1)} = 0.02 \quad (3)$$

$$CR = \frac{CI}{RI} = 0.012 < 0.1$$

Finally, the pairwise comparison is constructed, and result will be described in section 4.

4. Results and Discussion

The questionnaire is sent to the three experts in the form of a QR code or a webpage link. Since the webpage's submission button only allows the submission of completed questionnaires, the collected data were complete and effective. The result from questionnaire will be normalized and calculated using equation (1) from section 3 as shown in Table 2.

Table 2. Weight priorities

Factors	B1	B2	B3	B4	B5	B6	B7	weight
B1	0.46	0.60	0.57	0.39	0.19	0.30	0.26	0.39
B2	0.09	0.12	0.23	0.08	0.19	0.15	0.16	0.14
B3	0.09	0.06	0.11	0.39	0.19	0.30	0.19	0.19
B4	0.09	0.12	0.02	0.08	0.19	0.15	0.16	0.12
B5	0.09	0.02	0.02	0.02	0.04	0.01	0.10	0.04
B6	0.11	0.06	0.03	0.04	0.19	0.07	0.10	0.09
B7	0.06	0.02	0.02	0.02	0.01	0.02	0.03	0.03

The weights of each factor are B1(0.39), B2(0.14), B3(0.19), B4(0.12), B5(0.04), B6(0.09), B7(0.03), respectively. Then, the package recycling method pairwise comparison is computed. The result is shown in Table 3.

Table 3. Pairwise comparison of two package recycling methods

Alternative layer weight ordering	
C1. Cainiao courier station recycle	0.83
C2. Campus garbage sorting	0.15

The weight of each recycling method is Cainiao courier station recycle (0.83) and campus garbage sorting (0.15), respectively. The result show that Cainiao courier station recycle method is the best candidate of package recycling method in Yunnan University.

6. Conclusion

6.1 Conclusion

The research of express package recycling method is of great significance to the development of China's packaging recycling industry, which is conducive to improving the utilization of resources, reducing the pollution caused by traditional packaging waste disposal methods to the ecological environment, and promoting the development of reverse logistics and circular economy. This research aims to select an optimal recycling mode of express package and provide suggestion for Yunnan University to implement express garbage recycling. First, the factors which impact the express package recycling were extracted through literature review. Then, the questionnaire is sent to experts of reserve logistics management to assess the importance of each factor for making the pairwise comparison matrix. Then, the AHP model is computed. As the result, the weight of Cainiao Courier station recycle mode is 0.83 while another is accounted for 0.15. This significant result express that he recycling method of Cainiao station is more preferable with consumers.

6.2 Study the factors which affect the current packaging recycling development in campus

Recycling factors can be divided into subjective factors and objective factors. Subjective factors can be understood as the recycling factors influenced by subjective reasons of consumers, such as consumers' recycling awareness and the convenience of package recycling. Objective factors refer to the recycling factors influenced by the behaviour of external subjects such as the government and enterprises, such as recycling cost, package standards, incentive policies, recycling channels, and intelligent management. After getting these seven factors, in the next step the researcher established the AHP model and design the questionnaire based on all the factors that impact package recycling.

6.3 Select the best candidate of Yunnan university recycling mode through AHP method.

The researcher collected data by sending questionnaires to experts, designed pairwise comparison matrix by analysing data with mean value method, and then designed AHP model. Through the calculation, the weight of all of the factors is recycling awareness (0.39), policies (0.14), convenience (0.19), recovery cost (0.12), unified packaging standard (0.04), recycling channels (0.09), Intelligent management (0.03), respectively. The researcher uses the mean value method to combine the three answers from experts into single values. Then using these data to compute the weight priorities of two given recycling mode when considering one given factor and show the final weight of

recycling mode. According to Table 3, we can see the CAI Niao Courier Station Recycle mode are the first ranked with the weight score of 0.83 from three experts, which means the recycling method of Cainiao Station is more popular among consumers, and the management level of Cainiao Station is higher, which is more suitable for promotion and use in campus. Therefore, the CAI Niao Courier Station Recycle mode is the best candidate of packaging recycling mode in Yunnan University.

6.4 Limitation of the research

The selection of recycling mode plays an important role in improving the efficiency of packaging recycling and optimizing the reverse logistics system for the campus. It is also conducive to improving the utilization of resources and reducing the environmental pollution caused by packaging discarding. However, there are some limitations in the research. Firstly, the sample size is small. Because Yunnan University has a limited number of experts whose research direction is reverse logistics, the opinions of only three experts were collected in this research. Secondly, the survey scope is narrow, because the packaging recycling mode suitable for universities may not be suitable for other places such as communities. In addition, literature analysis and AHP decision-making methods are highly subjective, and future research needs to use more mathematical methods to reduce the influence of subjectivity on research.

References

- Wang J, Rao X F. "Recycling of Express Packages in Higher Education Institutions: Problems and Solutions." *Green Packaging Research*.45-49,2017.
- Lin Shidong, GAN Shenghua, LI Hongbin, Wan Lei. "China's Waste textile Recycling model and high-value utilization direction," *Textile Guide*.25-28, 2017.
- 2019 Campus Express Industry Development Report, <http://www.chinacacm.ORG/content/6165.html>.
- Liu G Q, Huang X Y, Jia Y L. "Research on the recycling mode of reverse logistics of packaging materials under cyclic symbiosis economy," *Low carbon economy*, 2014.
- Li Z J, Li H. "Innovation of express package recycling mode based on network crowdsourcing under government management," *Packaging engineering*.133-138, 2018.
- Zheng W Y, Meng Y P. "Linear programming model of green reverse logistics network under the guidance of the government -- A case study of express package." *Journal of Central China Normal University (Natural Science Edition)*.519-525, 2017.
- Liu Q G, Gao Y N. "Simulation research on campus express package recycling system considering enterprise benefits," *Packaging Engineering*.151-158, 2019.
- Ma P. "Research review based on bibliometric analytic hierarchy process," *Economic Research Guide*.6-8, 2018.
- Shen Z D. "Establishing the performance evaluation system of state-owned enterprises by the analytic hierarchy process," *Audit Research*.106-112, 2013.
- Yang J, Wang Z Q, Jin G, Cheng B Y, Hou X H. "Post-implementation benefit evaluation of land consolidation project based on AHP and fuzzy comprehensive evaluation," *Resources and Environment in the Yangtze Basin*.1036-1042, 2013.
- Sun C X, Li H Y, Li R Q, Wang X. "Application of Analytic Hierarchy Process (AHP) in Comprehensive Evaluation of Management Level," *Industrial Technical Economics*.72-78, 2013.
- Feng W Y, Zhu S G, Li X H. "Evaluation of tea culture tourism resources based on analytic hierarchy process -- a case study of Jiangsu Yixing Yangxian Tea Culture Exposition Park," *Journal of Nanjing Agricultural University: Social Sciences Edition*.127-134, 2013.
- Wei T L. "Construction of employment quality evaluation model for college graduates based on AHP," *Education and the Economy*.43-47, 2013.
- Wang Q P, Song X M. "Study on evaluation of transportation design scheme of coal enterprise general drawing based on AHP - entropy weight fuzzy assignment combination model," *Industrial Technical Economics*.45-52, 2013.
- Zhang Yi. "Research on Logistics Cost and Benefit Distribution of Express Packaging Recovery in Colleges and Universities". Master's Thesis, Southwest Jiaotong University.2018.
- Qian Congli. "Research on Delivery Packaging Recycling from the Perspective of Closed-Loop Supply Chain". Master Dissertation, Zhejiang Sci-Tech University.2019.
- Li Mingkun, He Hailong. "A tripartite game analysis of reverse logistics of express package under limited regulation". *Industrial Engineering and Management*. 26(01).2021.
- Zhipeng Qiu, Ze-hao Xu, Haoxuan Su & Zihao Liang. "A Study on the Recyclable Mode of Express Package Based on Green Logistics ". *National Circulation Economy*,9-11.2020.

- Gang Du." Study on the design and planning of waste household appliances recycling plant facilities ".Hefei University of Technology, 2005.
- K.Sander,Schilling S, Naoko T, et al. "The Producer Responsibility Principle of the WEEE Directive ". 21 (6) : 312-315.2007.
- Liang Liao." A study on commodity express packaging under the background of online retail ". Packaging Engineering,38(16):43-47.2017.
- Wang Jing, Zhu Aihong." An empirical study on the use intention of package recycling function express cabinet based on UTAUT model ".Packaging Engineering,40(17):131-137.2019.
- Wang Ziyi, Zhang Xuebin, Jiang Dali, Fang Haiyang. "A study on the optimization of the recycling process of university express package based on intelligent logistics ".Packaging Engineering,39(23):20-24.2018.
- Li Lulu, Tian Liping, Li Dongning. Research on Delivery Packaging Recycling Strategy Based on Differential Pricing and Government Subsidy [J].Ecological Economics.36(9):204-209.2020.
- J. R. Robinson,A.D.Read."Recycling Behaviour in a London Borough: Results from Large-scale Household Surveys ". Resources Conservation & Recycling,45(1):70-83.2005.
- Wang, Y., Wang, H., Wang, H. "Reverse logistics in China: A case study". Journal of Logistics Management,14(6):447-465.2009.]
- J.Vining,A.Ebreo."What makes a recycler? A comparison of recyclers and nonrecyclers".The Environment and behaviors, 22 (1) : 55-73.1990.
- Guo Lijuan & Bi Xiaoqing." A study on recycling cost of express package waste under circular economy ".Value Engineering (02),100-101. 2020.
- Zhao B Y, Shi K J, Sun B. "Comparative analysis and enlightenment of packaging recycling systems abroad," Ecological Economics.103-106, 2009.
- Cao Xijing, Zhang Jie. "Discussion on Logistics Management of Packaging Recycling,"Packaging Engineering,189-191, 2019.
- Yang Fang. "A Brief analysis of the solution to the problem of difficult recovery of express package," Logistics management.23,36-38, 2016.
- Fang, C.Q., Li, T.H., Jing, D.Q., "Research progress in the recovery and reuse technology of packaging waste polymers," Materials Review.47-49, 2017.
- Liu Guoqiu, Huang Xiaoyong, Jia Yanglei. "Research on reverse logistics recovery model of packaging materials under cyclic symbiosis economy," Low carbon economy, 2014.
- Dong Qiyue, PAN Junchang. "Consumers' Willingness to classify and recycle express packaging," Green packaging Research.6,50-58, 2014..

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