Abstract. Based on the theoretical framework of the principles and methodologies of service design, this study adopts the express delivery points in universities in Beijing as the research subject. Through field visits and interview-based investigations, this paper analyzed the handling of express packaging. This investigation aims to systematically resolve the significant issues caused by the improper utilization of express packaging—such as extensive accumulation and waste—through a well-thought-out service system design. The ultimate goal is to promote a sustainable design for the express packaging recycling system in universities. In the end, a comprehensive online and offline recycling system was established to improve the circular use of express packaging and materials and to reduce the consumption of paper resources. This study hopes to provide valuable insights for the overall express packaging recycling system design in the country.

Keywords. Service design; express packaging; recycling system; sustainable design

1. Introduction

With the rapid development of technology in China and the significant growth of internet technologies, especially under the current context of the ongoing pandemic, more and more Chinese people are turning to online shopping. This trend has also stimulated the rapid growth of the e-commerce industry. According to data from the National Postal Bureau, annual express service volume in China has grown nearly 18 times over the past decade, ranking top for nine consecutive years worldwide. In 2020 alone, the total express deliveries reached 833 million parcels (as shown in Table 1). By 2023, the daily processing capacity exceeded 700 million, with an average annual parcel count of nearly 80 per person. However, the ubiquity of online shopping has led to significant resource waste, and most importantly, the issue of accumulating packaging waste is becoming increasingly severe. One of the primary sources of this packaging waste is university express delivery stations.

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Against the backdrop of such waste, the Chinese government has proposed green logistics and green packaging industry standards and requirements. However, due to the current resource constraints, the primary goal should be shifted from green deliveries to a more critical problem of resource recycling. Thus, enhancing the recycling rate of express packaging and reducing the consumption of paper resources is a potential direction for the express industry.

Table 1. National Express Delivery Volume from 2010-2020.

<table>
<thead>
<tr>
<th>Year</th>
<th>National Express Delivery Volume (in 100 million pieces)</th>
<th>Year-on-Year Growth (%)</th>
<th>Express Delivery Revenue (in 100 million yuan)</th>
<th>Year-on-Year Growth (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2010</td>
<td>23.4</td>
<td>25.9</td>
<td>574.6</td>
<td>20.0</td>
</tr>
<tr>
<td>2011</td>
<td>36.7</td>
<td>57.0</td>
<td>758.0</td>
<td>31.9</td>
</tr>
<tr>
<td>2012</td>
<td>56.9</td>
<td>54.8</td>
<td>1055.3</td>
<td>39.2</td>
</tr>
<tr>
<td>2013</td>
<td>91.9</td>
<td>61.6</td>
<td>1441.7</td>
<td>36.6</td>
</tr>
<tr>
<td>2014</td>
<td>139.6</td>
<td>51.9</td>
<td>2045.4</td>
<td>41.9</td>
</tr>
<tr>
<td>2015</td>
<td>206.7</td>
<td>48.0</td>
<td>2769.6</td>
<td>35.4</td>
</tr>
<tr>
<td>2016</td>
<td>312.8</td>
<td>51.4</td>
<td>3974.4</td>
<td>43.5</td>
</tr>
<tr>
<td>2017</td>
<td>400.6</td>
<td>28.0</td>
<td>4957.1</td>
<td>24.7</td>
</tr>
<tr>
<td>2018</td>
<td>507.1</td>
<td>26.6</td>
<td>6038.4</td>
<td>21.8</td>
</tr>
<tr>
<td>2019</td>
<td>635.2</td>
<td>25.3</td>
<td>7497.8</td>
<td>24.2</td>
</tr>
<tr>
<td>2020</td>
<td>833.6</td>
<td>31.2</td>
<td>8795.4</td>
<td>17.3</td>
</tr>
</tbody>
</table>

2. An Overview of Service Design

Service design is effective in planning and organizing all aspects related to a service—people, infrastructure, communication, materials, etc.—to enhance user experience and service quality. By establishing a user-first service standpoint and tracking all touchpoints in the experience flow, the aim of service design is to create an excellent user experience. The express packaging recycling system needs to consider everyone involved in the express service as well as workers at express delivery points, infrastructure, communication, tangible materials, etc. In this connection, express packaging serves as the central element linking all stakeholders.

3. The Current Situation of University Express Packaging Handling

Statistics show that university students are one of the primary online shopping demographics, making university express deliveries a potential market under the booming e-commerce industry. Currently, there are various operating models for university express deliveries, including proprietary operations by courier companies, centralized pickups, scattered pickups, automated pickups, campus O2O, and crowd-sourced deliveries. The primary materials used for packaging are plastic bags, paper packaging, foam, and fillers. Among these, paper-based packaging is the most used one, leading to the most waste and environmental pollution.

Taking a particular university in Beijing as an example, a survey of 150 students revealed that 72.5% of students shop online 1 to 5 times a month, 25% do so 5 to 10
times a month, and 2.5% shop online more than 10 times a month (as shown in Table 2).

Table 2. Online Shopping Frequency of Students from a University in Beijing (Based on a Sample of 150 Students).

<table>
<thead>
<tr>
<th>Monthly Online Shopping Frequency</th>
<th>Number of Students</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 - 5</td>
<td>108</td>
<td>72.5%</td>
</tr>
<tr>
<td>5 - 10</td>
<td>39</td>
<td>26%</td>
</tr>
<tr>
<td>Over 10</td>
<td>3</td>
<td>2%</td>
</tr>
</tbody>
</table>

At the northwest entrance of the campus, there is a venue of concentrated express delivery points from various companies for the convenience of the staffs and students to pick up package. However, these points often have littered packaging waste around them, not only tarnishing the aesthetics of the campus but also resulting in significant resource wastage (as shown in Figure 1). Most of the discarded packaging ends up at waste disposal sites, with only a small portion being reused by couriers. This waste issue stems from two main factors: a lack of recycling awareness among students and an absence of a systematic recycling infrastructure.

Given that Beijing has millions of university students generating tens of millions of express parcels annually, it signifies the production of an equal number of packaging materials, which in turn leads to immense packaging waste.

![Figure 1. The Current Situation of Packaging Accumulation at an Express Station of a University in Beijing.](image)

4. University Express Packaging Recycling System Based on Service Design

Given the current situation of express packaging in universities in Beijing, this study adopts the principles and methodologies of service design and proposes a comprehensive online and offline recycling system. This system provides students with self-service express packaging recycling bins, coupled with a points reward and supervision mechanism to encourage students to actively recycle their packages. This is done to improve the circular use of express packaging and materials, reduce the consumption of paper resources, and thereby refine the university express packaging recycling system (as shown in Figure 2 and Figure 3).
4.1. Establishment of Offline Self-Service Recycling Bins

The bins owned by third-party companies are set up at central express delivery points within the university. Students can classify and drop off their used express packages. The third-party companies either assign dedicated personnel or collaborate with university logistic staff for managing these recycling bins. Managers can monitor the storage status of these bins in real-time via an app, ensuring timely cleanup and transport of the collected materials to processing facilities. Here, well-preserved packaging is either reused or reprocessed into new express packaging, which is then sold to e-commerce businesses or courier companies.

According to the common materials for express packaging, the recycling box is equipped with four recycling barrels, namely paper packaging, plastic packaging, foam packaging materials and fillers (as shown in Figure 4). And based on the daily production volume, the capacity of the recycling bucket is divided, with the largest capacity being the paper packaging recycling bucket and the smallest being the filling material recycling bucket. The overall height of the recycling box is 185cm, and the height range of the delivery window on the front of the recycling box is 115-170cm. The delivery range is around 110-120cm, which is comfortable for people to stand and reach for objects. The entire window is convenient for users to drop the packaging without lifting it, reducing delivery difficulties. At the same time, there is also a screen on the front of the recycling bin, which mainly functions to connect QR codes, view user information, view the remaining amount of the recycling bin, and provide online feedback and messages. On the back of the recycling box, there is an electrical box area, a heat dissipation zone, and four recycling box entrances and exits. The height of the
handle of the recycling bin is 105cm, which is less than the distance from the waist of an adult to the ground, making it convenient for staff to pull the recycling bin from the inlet and outlet of the box for cleaning and maintenance (as shown in Figure 5).

4.2. Online Behavior Tracking and Incentive Mechanisms

Before depositing their express packaging into the recycling bins, students can either scan a QR code or use an app to connect with the system. The system then records the details of the deposit and calculates the points the student earns based on the type and weight of the packaging material. Once they accumulate enough points, students can redeem various items from an in-system store. By integrating online behavior tracking with incentive mechanisms, a comprehensive online-offline service model is realized, fostering a sustainable express packaging recycling system.

4.3. Recycling System Workflow

The Campus Green Station APP is an app configured for the recycling system, which
allows students and management personnel to learn about the information of the recycling bin and complete related operations for express packaging recycling. Through the app login page, you can enter user mode and administrator mode respectively.

- **Workflow for user**
  
  The overall framework of the user mode is divided into four modules: Home, Mall, Me, and Know-how. “Home” is the first and core scenario of the app, which focuses on searching for nearby collection points, selecting and opening collection boxes, and recording delivery information. “Mall” is the main scenario of the app, focusing on the functions of points record, query, redemption and so on. “Me” includes functions such as personal information modification and software settings, etc. “Know-how” mainly includes functions such as pushing environmental protection knowledge such as how to classify and recycle, and redeeming points through learning.

  After unpacking their parcels, user can scan a QR code or use an app to connect with the system. They then choose the appropriate bin for their packaging material, and upon confirmation, the corresponding bin opens. After depositing their packaging, the system scans and compresses the material, weighs it, and logs the details. Points are then awarded to the user based on the type and weight of the deposited material. Once the points are credited, the bin closes, completing the deposit process. The system store displays items that user can redeem with their accumulated points (as shown in Figure 6).

![Figure 6. User app interface display.](image)

- **Workflow for Administrator**
  
  The overall framework of the administrator mode is divided into four modules: Capacity View, Information Feedback, Repair Record, and Add Device. “Capacity View” can show the remaining capacity of the equipment. “Information feedback” includes summarizing and viewing equipment information. “Repair Record” displays real-time repair requests and past maintenance records. “Add Device” is the function of adding devices and inputting device location, data, name and other related information.

  Administrator can visually inspect the amount of waste in each bin through transparent sections on the bins. Additionally, they can use the app to monitor the storage status in real-time. When the bins are full, they promptly clean and package the
waste by type, transporting it to central collection points. These materials are then sent to processing plants for sorting and repurposing. If a bin malfunctions, the app sends a warning notification, prompting the manager to address and resolve the issue(as shown in Figure 7).

Figure 7. Administrator app interface display.

5. Conclusion

With the rapid rise of e-commerce and express delivery industries, improper handling and disposal of express packaging have led to vast amounts of waste and accumulation. However, these challenges can be properly addressed through employing effective design principles. By championing the cause of sustainable express packaging recycling systems and enhancing the recyclability of express packaging and materials, the paper consumption can be minimized efficiently. The findings and proposals of this paper can serve as valuable references for devising recycling systems for express packaging countrywide.

References

[7] Li Jinyu, Research on Incentive Mechanism for Express Packaging Recycling Based on Post Station Service Platform, Dalian University of Transportation Learning, 2020.
[12] https://www.doc88.co