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Multi-Functional Luggage based on Human Centered Design for Small Unit Rental Population: A Case Study of Shanghai and Hangzhou, China

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ABSTRACT

In China's first-tier and new first-tier cities, such as Guangzhou and Shanghai, rapid urban development and talent attraction policies have drawn many young people seeking opportunities. However, this influx has intensified housing challenges, particularly for rental population living in small-unit housing. With limited storage space and frequent relocation needs, suitcases have become essential for these rental population—especially university students and non-local residents. Yet, existing luggage products often fail to meet their specific needs, including low usage frequency, and idle luggage occupying valuable space.

Currently, the market lacks research and design focused on multi-functional luggage tailored to the needs of small-unit housing rental population in these cities. To address this gap, the study emphasizes the need for innovative luggage solutions grounded in the Human-Centered Design (HCD) theory. The research employs questionnaires, surveys, and interviews to investigate the behaviors and pain points of this demographic. The objective is to design luggage that integrates HCD principles, addressing rental population specific requirements and enhancing their everyday lives.

The research resulted in a multifunctional luggage prototype with several innovative features. It maintains the basic transportation function of traditional luggage while incorporating the functionality of a wardrobe. In terms of space optimization, the luggage features a modular partition structure inside the compartment, allowing users to organize their belongings based on individual preferences. Ultimately, this research aims to introduce a new form of multi-functional luggage that not only addresses storage and usability challenges but also aligns with the unique lifestyles of rental population living in compact urban housing.

Keywords: Multi-Functional Luggage, Small Unit Housing and Rental Population, Guangzhou and Shanghai, Human-Centered Design (HCD)

Introduction

According to the 2021 City Business Charm Ranking released by the New First-Tier City Research Institute of First Financial News (N. F. t. C. R. Institute, 2021.08.01), Shenzhen, and Guangzhou continue to rank among the top four first-tier cities in China. As shown in the upper left image of Figure 1. Meanwhile, fifteen new first-tier cities, such as Chengdu and Hangzhou, closely follow, demonstrating strong development potential and offering more employment opportunities. These cities attract a large number of young people each year; however, the accompanying population growth has led to increasing challenges in

the rental housing market. Data from January 2023 shows that Hangzhou's rental prices are above average, with both monthly and yearly increases outpacing cities like Beijing and Shanghai, indicating a clear short- and long-term upward trend, (M. R. Institute, 2023) . As shown in the upper right graph of Figure 1.

Objectives of the study

1. To study and to survey users demand, behavior, situation, and function of multi-functional luggage in current Chinese market.
2. To apply Human Centric Design theory(Norman, 2013) for design a prototype model of multi- functional luggage.
3. To purpose prototype model and suggestions of multi- functional luggage for small apartment rental population.

Analysis of Rental Housing Area Supply

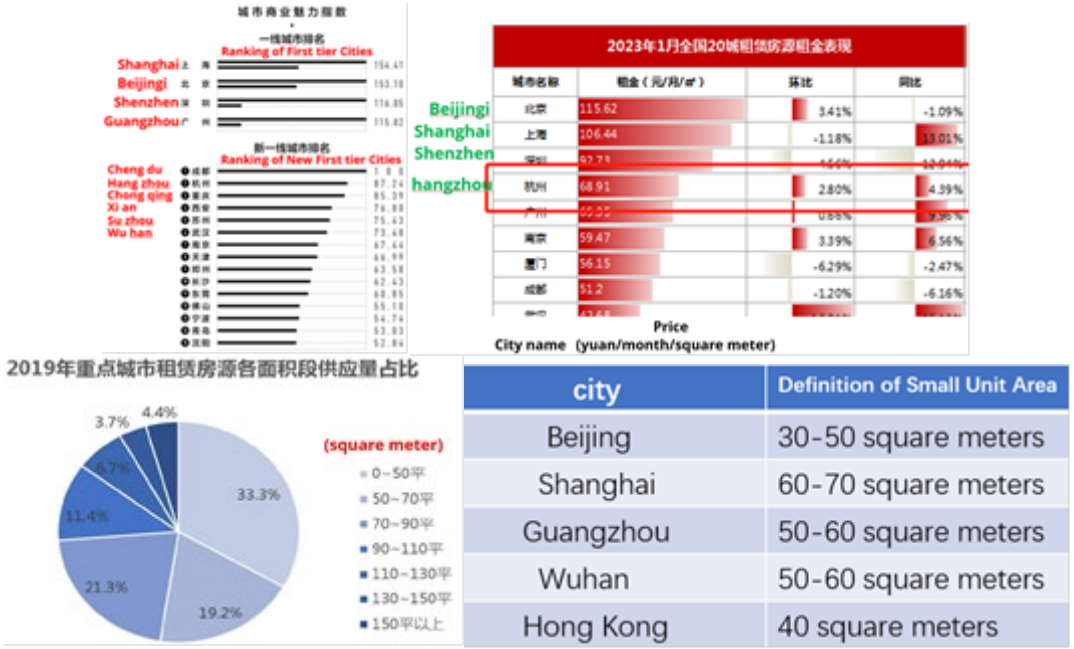
With the growing size of the national floating population, the proportion of small-unit housing in the rental market has been increasing year by year. According to authoritative data from 2019 (A. R. E. R. Institute, 2019), small-unit residential properties with a rental area of less than 50 square meters accounted for 30% of the total rental housing supply across key cities, As shown in the lower left image of Figure 1. These types of small-unit apartments are typically rented by college students and young professionals who have just entered the workforce. Due to their compact size and highly transitional nature, they have become an ideal choice for students, young workers, and freelancers within the middle- to low-income demographic.

The current situation, analysis and pain point of small unit residential buildings in China

Small housing includes small-unit residences, and student dormitories. In major cities across China, small-unit housing is typically defined as having a floor area between 30 and 60 square meters, as shown in the lower right image of Figure 1, designed to meet basic living functions.

Ultra-small-unit housing has become a short-term transitional option for young people due to its low cost and limited usable space, with multi-person sharing also being common. Among small-unit rental population, the majority are young individuals and students with high mobility, for whom luggage plays a significant role in daily life.

As the number of rental population continues to increase, the demand for luggage usage has been rising steadily. However, current luggage designs on the market lack diversity and multi-functionality, making it difficult to meet the specific needs of rental population living in small-unit housing.



city	Definition of Small Unit Area
Beijing	30-50 square meters
Shanghai	60-70 square meters
Guangzhou	50-60 square meters
Wuhan	50-60 square meters
Hong Kong	40 square meters

Figure 1. Urban Commercial Charm Index, Rental performance of rental properties in 20 cities nationwide in January 2023, The proportion of supply of rental housing in different areas of key cities in 2019, Definition of Small Unit Residential Area in Large Domestic Cities in 2021
Source: SOHU Network (2021); Maidian Research Institute Data (2023); China Housing Rental Report (2019); Baidu Network (2023)

Literature Review

1. Environmental condition of small Unit tenants and definition of small unit tenants

As first-tier and new first-tier cities continue to attract a large number of young people, demand in the rental housing market is steadily increasing. Cities such as Shanghai and Hangzhou have drawn many young individuals with high-quality career opportunities and promising development prospects. However, high housing prices combined with limited income levels have compelled many young rental population to opt for small-unit or shared housing. According to relevant data (Z. R. Institute, 2022b) (Z. R. Institute, 2022a) rental demand in both Shanghai and Hangzhou has increased year by year, while the proportion of small-unit residential supply has also risen steadily. These units have become a common transitional choice for low-income rental population, as shown in Figure 2.

This study defines small-unit rental population as low- to middle-income individuals aged 18–30 in Hang Zhou and Shang Hai, such as graduates, young workers, and freelancers, living in rentals under 50 square meters. Due to high housing costs, they often opt for shared or full-unit rentals, with personal living spaces typically between 5–20 square meters.

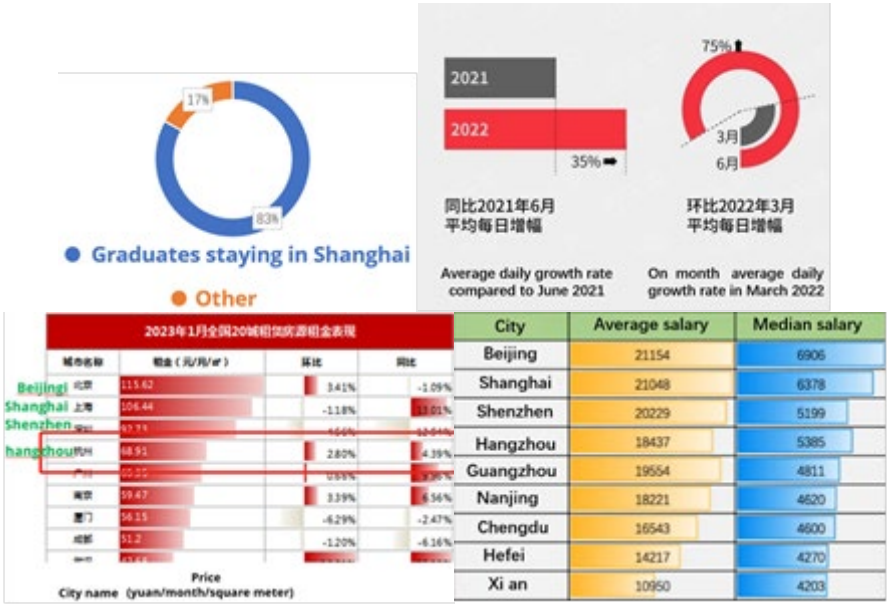


Figure 2. Development of local graduates in Shanghai in the past three years in 2023, Changes in rental volume of houses in 2023, Rental performance of rental properties in 20 cities nationwide in January 2023, Average salary and median salary in major cities across the country in 2022
Source: Zizi Research Institute (2022); Maidian Research Institute, (2023); Baidu Network, (2024)

2. Related design theories and research

Human-Centered Design (HCD) is a user-focused approach that prioritizes the needs, behaviors, and comfort of users throughout the design process. (Norman, 2013) It integrates science and technology to optimize products beyond their basic functions, while combining art and human values to enhance aesthetic and emotional appeal. HCD emphasizes physical and psychological care, social inclusivity, and environmental sustainability, especially for vulnerable groups. In multi-functional luggage design, HCD ensures the product is not only functional and easy to use in compact living spaces but also considers user comfort, emotional needs, and lifestyle challenges. By studying users' behavior and physiological characteristics, designers can create luggage that minimizes effort, maximizes space, and integrates seamlessly into the user's living environment. Ultimately, HCD provides a theoretical and practical foundation for designing truly user-oriented luggage that balances utility, safety, sustainability, and user satisfaction.

3. The current situation of multi-functional luggage in China

China as the world's largest luggage producer, China's luggage industry leads in production capacity but remains relatively weak in design innovation and suffers from severe product homogenization. Literature shows that most multi-functional suitcases prioritize appearance over function. While countries like Japan and Israel offer compressible designs, their high prices fail to meet the practical needs of specific users, such as small-unit tenants. The design of certain suitcases—particularly their internal structure—often lacks functional innovation and falls short of users' expectations for versatility (Shu, 2007). For instance, many suitcases do not include features such as dry and wet separation zones or designated compartments for special items, which creates inconvenience for users who require categorized storage (Ying, 2019). Although market demand for multi-functional suitcases continues to grow, existing designs often aren't practical for small-unit living.

Research questions

1. What is demand, current situation, and function of multi- functional luggage for small apartment rental population?

2. How to improve and what is a prototype model of multi- functional luggage with Human Centered Design theory for small residential rental population?

Research scope

The scope of this study focuses on the design of innovative multi-functional luggage for the target population—young workers and university students living in small-unit rental housing within case study cities. These cities have been systematically selected to represent both first-tier and new first-tier cities in China.

The theoretical framework guiding the design process is based on Human-Centered Design (HCD) concepts as proposed by Donald Norman (2013), emphasizing user needs, usability, and functionality in real-life contexts.

The data collection period spans from March 2024 to January 2025. A mixed-methods approach is employed, integrating tools such as questionnaires, interviews, expert consultations, user experience surveys, and observational methods to ensure a comprehensive understanding of user behavior, needs, and design expectations.

Research Method

The study employs a mixed-method approach combining qualitative and quantitative research to develop multi-functional luggage tailored to small-apartment rental population in China's first-tier and emerging cities. Guided by Donald Norman's Human-Centered Design (HCD) principles, the research integrates questionnaires, interviews, observations, and user feedback. The questionnaire, based on literature review and expert evaluation, was pilot-tested with 50–100 participants and later distributed to 400 respondents. Interviews involved three luggage company representatives and six experienced users, while observations examined storage behavior in small living spaces. Targeting rental population aged 22–35 with varied occupations, the study used random sampling to ensure diverse participation. A pilot survey of 150 participants (108 valid responses) helped refine questionnaire clarity and content by addressing vague questions and limited answer options, improving insights on user preferences in style, material, and function.

To enhance efficiency and accuracy, data collection was supported by online tools. The findings offer actionable insights for designing multi-functional luggage that meets the practical needs and lifestyle preferences of young urban rental population, thereby addressing existing gaps in the current market. The overall research methodology is illustrated in Figure 3.

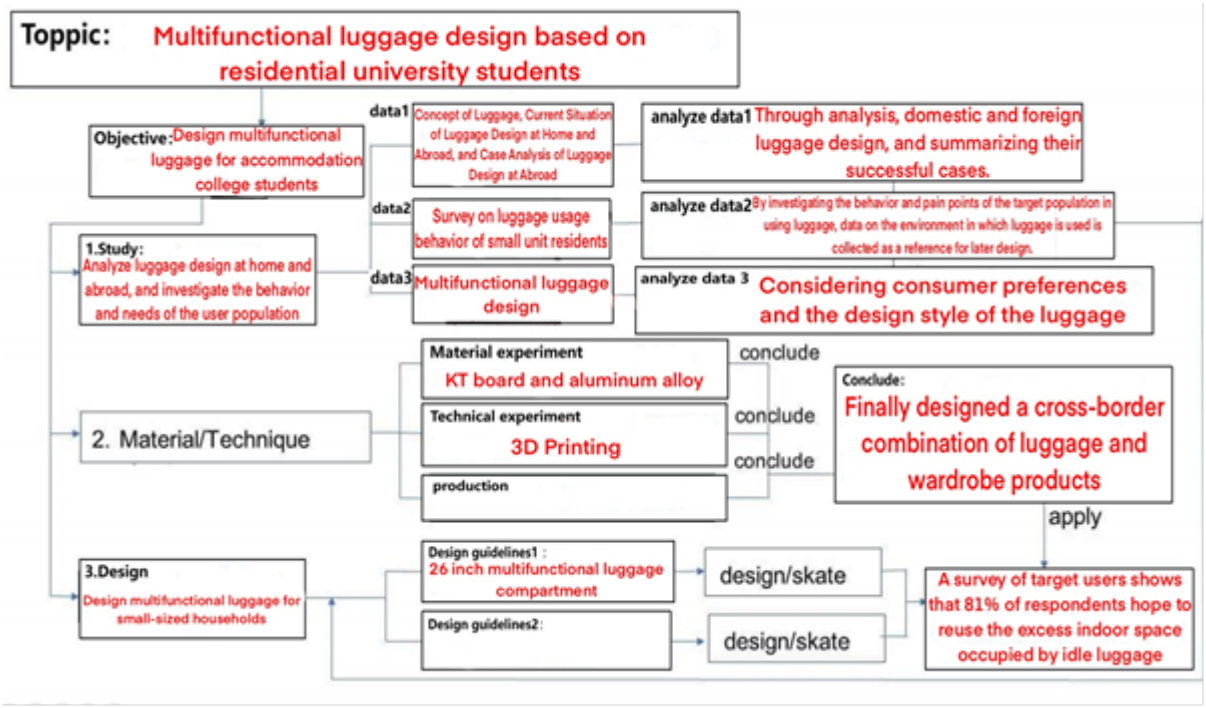


Figure 3. Research diagram presents research methodology
Source: Author (2024)

Research Findings

The purpose of data collection is to address Research Question 1: What is the demand, current situation, and function of multi- functional luggage for small apartment rental population? The study aims to understand users' demands, pain points, behaviors, and the functionality of multi- functional luggage in the current market, particularly in relation to competitor products targeted at small apartment rental population. Through direct engagement with the target audience, including visits and discussions, the study seeks to uncover the direction for future functional design and to gather users' ideas for luggage design. Based on the findings from interviews and communications, the demand for the product was more clearly defined. The research also aimed to gauge the target audience's recognition of the necessity of this research topic and identify specific design features for multi-functional luggage tailored to small-apartment rental population in first-tier cities. By analyzing the behavior of the target audience and their relationship with luggage, and combining these insights with the research findings, a multi-functional luggage product suitable for the target demographic was developed.

1. Questionnaire (150 pilot test and 400 questionnaire survey)

The questionnaire was developed based on a comprehensive literature review of academic articles, data related to the environment of small apartments, small apartment rental population, multi-functional luggage products in China, as well as relevant theories and case studies. Subsequently, a pilot test was conducted with 150 respondents to assess the questionnaire's comprehension, validity, and to gather feedback. The questionnaire was distributed via an online platform from July 3rd to July 6th, 2024. After collecting post-test feedback, the study revised the questionnaire and submitted the revisions to experts for assessment. Once the revised questionnaire was approved, the final version was distributed to 400 respondents to collect data from the target sample. This pie chart gathers the multi-functional design points of almost all suitcases currently on the market.

By analyzing the collected data, the respondents' design requirements for multi-functional luggage mainly focus on three key aspects, as shown in Figure 4:

1. High frequency of use and portability: Due to frequent relocations and the specific nature of their work, respondents require lightweight and easily portable suitcases.
2. Multi-functionality and space-saving: Users expressed the need for luggage that can be transformed into other useful furniture or storage solutions when not in use, to optimize limited space.
3. Internal organization and storage optimization: There was a strong demand for hidden storage compartments, multi-zone designs, and additional features, indicating that users prioritize the practicality and organizational capabilities of their luggage.

This luggage design research will focus on the above three points for design.

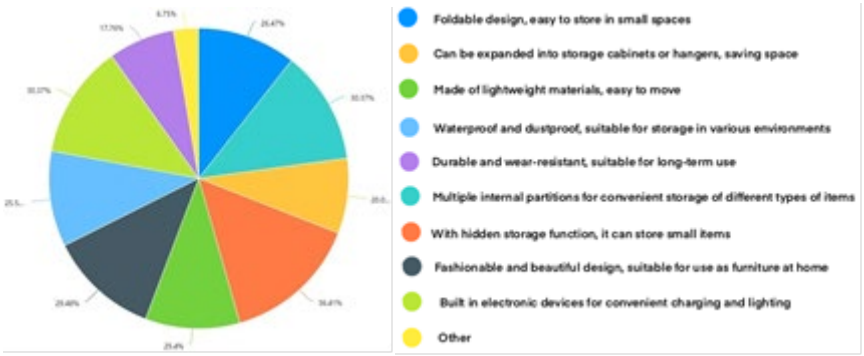


Figure 4. Target audience's demand statistics for multi-functional luggage function in small apartments
Source: Author (2024)

2. Users Interview section

To gain a more accurate understanding of the target audience's usage behavior and needs, user interviews were conducted with six individuals from diverse professions and age groups, including designers, luggage store owners, brand owners, buyers, and the target audience (small-apartment rental population). The interview questions were tailored to each interview group, and one-on-one interviews were conducted online. The survey revealed the following key insights:

- Professions: For example, salespeople and frequent business travelers use luggage more frequently, while office workers mainly use it for storage purposes.
- Small-unit tenants: The limited space of small apartments restricts the number of luggage items that can be purchased, necessitating more efficient use of available luggage.
- Target users' perspective on luggage: For these users, luggage serves not only as a travel tool but also as an additional storage solution. By storing seasonal or infrequently used items, luggage helps maximize the use of limited space, underscoring the importance of effective space management.

By collecting feedback from representative respondents from different industries, we can further understand luggage. Selecting two individuals from each industry also enhances the comparability of the final feedback. This group is the easiest to come into contact with luggage, and through design, sales, and use, the entire process of luggage from scratch to use provides

convenience for future design research. At the same time, it has provided a more accurate expression of the demand direction for future products.

3. Observation

The third data collection tool used in this study was observation, aimed at gathering data on users' daily behaviors during both weekdays and weekends, as well as during special events and holidays. Observations were conducted at locations where luggage is frequently used, such as train stations, bus stations, airports, and other high-traffic areas. The goal was to observe both conscious and unconscious luggage usage behaviors in real-life scenarios to identify common pain points and potential design opportunities.

The specific focus of the observation research included: How individuals use luggage in small living spaces, Storage behaviors of small-unit tenants before traveling, Usage patterns of luggage during travel, Storage practices for idle luggage after trips, Luggage usage behaviors during business trips.

The entire process of user behavior was documented through sketches and photographs, and the behaviors were broken down to identify key design insights, as shown in Figures 5. The collected data was then analyzed and organized to extract the users' usage habits, behavioral characteristics, and other relevant findings, which were summarized as follows:

Findings :

- Stacking and Disorganization: Luggage items are often stacked, leading to disarray when searching for specific items.
- Footwear Storage: Shoes require separate storage to avoid contamination, but are often compressed, which affects their longevity.
- Packing Challenges: Suitcases require flat, open spaces for packing, which is difficult in small apartments.
- Additional Carry Items: Users often carry extra backpacks for additional storage, even when they have large suitcases.
- Idle Suitcase Storage: Idle suitcases occupy valuable space in corners or on top of wardrobes, with no efficient solution for reuse.
- Packing Stress: The packing process is often tedious, leading to confusion and frustration.
- Separate Storage for Toiletries: Toiletries and medications are typically stored in separate bags to maintain cleanliness.
- From the overall observed issues, users require a multi-functional luggage product that integrates modular storage and can be converted into a furniture product.

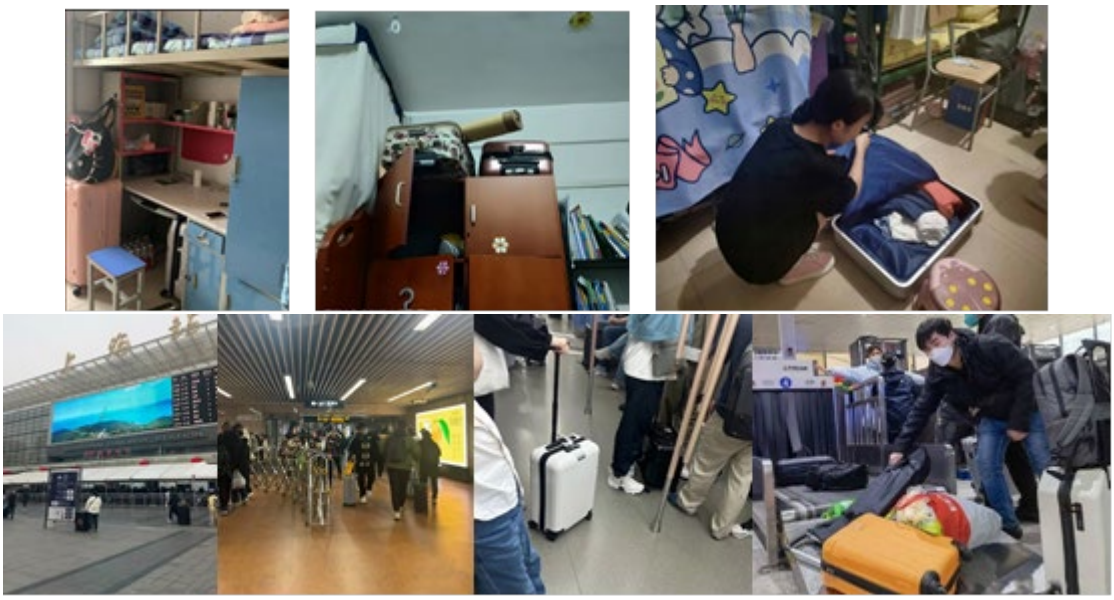


Figure 5. User's behavior on storage luggage at small rental unit and on traveling
Source: Author (2024)

Based on the research findings, the product design process will focus on the following aspects, while adhering to the principles of "Human-Centered Design":

1. Enhancing the Auxiliary Functional Design of Luggage:

High-frequency use and portability: The design will prioritize making the luggage lightweight and easy to carry suitable for frequent use.

Multi-functionality and space-saving: The luggage will feature versatile functions that allow it to serve multiple purposes and save space when not in use.

Optimization of internal organization and storage: The internal structure will be optimized to provide efficient storage and easy organization of items.

Improved recognition: The luggage design will enhance user recognition, ensuring that it stands out in terms of usability and design.

2. Selecting Appropriate Materials and Color Combinations:

Moderate price range: The materials chosen will ensure that the luggage remains affordable while maintaining quality.

Improvement of fragile parts: Special attention will be given to enhancing the durability of fragile parts of the product to ensure longevity.

Style alignment with target audience preferences: The overall style and aesthetic will be designed to resonate with the tastes and preferences of the target users.

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Design ideas and innovative points

This design study primarily addresses Research Question No. 2: What is the prototype of the innovative multi-functional luggage? The design is developed using the Human-Centered Design (HCD) concept, integrating insights gathered through a combination of research methods such as investigations, on-site observations, and interviews. These efforts have helped identify the pain points of current luggage products. Based on these insights, the study aims to optimize functionality, structure, and aesthetics to create more practical and user-friendly luggage solutions for the small-apartment tenant market.

Design Process: The HCD process begins with sketching, followed by feasibility evaluation. It then proceeds to design refinement, prototyping, and 3D rendering to produce a finalized solid model.

Conceptual Design: Guided by a people-oriented design approach, four preliminary conceptual luggage designs were proposed, addressing users' needs for functionality, comfort, and other relevant aspects of luggage.

Design Solution:

1. Multi-functionality: The design integrates basic luggage transport features with a convertible wardrobe functionality for small spaces. This includes a detachable hanger to reduce travel weight and a load-bearing module for real-time weight monitoring.

2. Durability: Made from lightweight, pressure-resistant, and wear-resistant PC material, the luggage ensures high drop resistance and long-term structural stability. The telescopic hanger structure is designed to minimize the risk of mechanical failure.

3. Space Optimization and Cost Efficiency: A modular partition system allows users to flexibly organize items. With a price range of 500-1000 yuan, this design eliminates the need for a separate wardrobe, maximizing space efficiency and reducing costs.

4. Comfort and HCD Integration: The luggage integrates comfort and Human-Centered Design by adding features like electronic tags for easy identification and adapting the design to serve as both storage and furniture for small spaces. It also addresses frequent user behaviors and pain points to suit real-life use.

The design proposal will be evaluated by experts through online interviews based on six criteria - multifunctionality, innovation, quality, sustainability, appearance, and price - in the form of a table. The sketch with the highest rating will be improved based on expert feedback. Complete the design drawing through sketching and modeling rendering. The product size is a 26 inch

The following is the final product rendering, is presented in Figure 6.



Figure 6. Product prototype and scene diagram
Source: Author (2024)

Another key aspect of the study is the creation process of the multi-functional luggage using the Human-Centered Design (HCD) theory for small residential rental population. This section focuses on answering Research Question No. 2: How can the prototype model of innovative multi-functional luggage be improved? The final product rendering has been refined based on expert feedback, and this rendering now represents the completed product form. Product Model Production: The luggage is constructed using a range of composite materials, including KT board and aluminum alloy pipes, Made purely by hand. These two types of materials have strong plasticity and are the best materials for making models. The manufacturing process is detailed in the diagram below, as shown in Figure 7.



Figure 7. Product model production diagram
Source: Author (2025)

Testing method: On-Site Testing: Users will test the products in real-life environments, such as rented apartments. They will be guided to complete specific tasks, including organizing, moving, and assembling detachable components.

A questionnaire survey was conducted with 10 participants to gather feedback on the luggage's functionality, innovation, quality, appearance, price, and overall satisfaction. Most

users chose "more satisfied" for all aspects, except two who selected "satisfied" for appearance and price. A sample test scenario is shown in Figure 8.



Figure 8. Product model production diagram
Source: Author (2025)

Discussion

1. Small unit rental households have become a huge potential customer for multi-functional luggage in China market in near future

Firstly, from the perspective of the frequent moving and high mobility needs of the target population, small unit tenants are predominantly young people, including newly employed professionals, students, and freelancers, who frequently relocate for work or study. This constant movement necessitates luggage that is portable, easy to carry, and efficient for storing their belongings. Secondly, the living space of the target users is limited to 30-50 square meters, requiring optimization of the luggage storage method. Rental population need luggage with multi-functional, categorized storage that allows them to easily organize their items in small spaces. Finally, in terms of cost-effectiveness and durability, they tend to prefer luggage that offers reasonable pricing and practical functions. Therefore, based on the above analysis, small unit tenants represent a significant potential customer group for multi-functional luggage in China.

2. Analysis of Future Trends in Customer Behavior of Multi-functional Luggage in China

Firstly, the rental population of small unit apartments will use their luggage according to changes in their environment, allowing the luggage to serve different functions in various settings. For example, when not in use, luggage can be assembled with internal structures as wardrobes to meet the space requirements of small unit apartments. This type of product will be more flexible and convenient, seamlessly integrating into the daily life scenarios of young users. Secondly, in the future, the interior design of luggage will focus more on efficient separation and the diversified utilization of space, enabling users to adjust their storage space flexibly to accommodate various storage needs. Additionally, the high demand for mobility has driven users to seek luggage with enhanced portability. In the future, luggage will be designed to be more lightweight, both in terms of material selection and structural design. Simultaneously, the lightweight, pressure-resistant, and low-cost repair designs will help reduce the overall cost of use for the target group. The future design of multi-functional luggage will also place greater emphasis on the diversification and personalization of its appearance, thereby significantly reducing the difficulty of locating luggage in dense environments.

3. Summarize

The research findings confirm that multi-functional luggage designed using Human-Centered Design (HCD) principles effectively addresses the storage and usability challenges faced by rental population in small-unit apartments. The study reveals that rental population value portability, space optimization, and internal organization—needs that current market products often overlook. These results align closely with existing research, such as Ying (2019), which emphasizes that most luggage lacks functional innovation and targeted user solutions.

Observation data and interviews further support the consistency with previous studies, showing that young rental population use luggage not just for travel, but also for in-home storage—validating the demand for integrated features like modular compartments and wardrobe functions. Additionally, the study echoes Norman's HCD theory (2013) by demonstrating the necessity of design focused on user comfort, daily behavior, and environmental limitations.

The prototype's wardrobe conversion, lightweight materials, and foldable structure directly address gaps noted in Shu (2007), who highlighted product homogeneity and lack of innovation in China's luggage industry. Due to location constraints, 10 Chinese students in Thailand were selected for the experiment, as the target population is based in China while the researchers are in Thailand. Therefore, this research contributes both theoretically and practically by offering a solution aligned with both user needs and established design theories.

Conclusion

This study adopts a Human-Centered Design (HCD) approach, targeting low- to middle-income rental population aged 22-30 living in small apartments in major cities. Through research, it identifies key pain points such as limited space, diverse storage needs, and frequent relocations. In response, the study introduces innovative solutions like wardrobe integration and modular storage to enhance the user experience.

Experts and users evaluated the design sketches for cost-effectiveness and functionality. The final design retains a simple rectangular form with features like luggage straps, storage modules, wardrobe conversion, foldable storage, weight display, and modular partitions. Made from lightweight, durable materials (PC, polyester fiber, aluminum alloy) in vibrant tones, the product is priced at 500–1000 RMB to remain affordable.

Through sketching, 3D modeling, and iterative evaluation, the final design integrates wardrobe functionality. It includes foldable hangers, hanging bags, and modular partitions to address daily storage needs and optimize space in small apartments, while also incorporating weight monitoring to enhance convenience. The limitation of this study is that the final product did not undergo commercial mass production.

The product model was tested through on-site use and questionnaires with 10 participants in real rental settings. Users evaluated its practicality in tasks like sorting and assembling. Feedback showed strong performance in multi-functionality, innovation, quality, and price, confirming the design effectively meets young rental population needs and provided insights for future luggage design.

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