

Article

Research Driven by User Demand for the Design of a Cross-Border Travel Credential Bag

Shuyun Li ¹, Xizhi Zhang ^{2,*}, Kuohsun Wen ³  and Jiawei Jiang ⁴ 

¹ Department of Product Design, Guangzhou University of Applied Science and Technology, Guangzhou 511300, China; lishuyun@gzasc.edu.cn

² Design Programme, Faculty of Humanities and Arts, Macau University of Science and Technology, Macao 999078, China

³ School of Design, Fujian University of Technology, Fuzhou 350118, China; khwen@fjut.edu.cn

⁴ College of Education, Jinan University, Zhuhai 519000, China; kevin_jiang96@yahoo.com

* Correspondence: xzzhang@must.edu.mo; Tel.: +853-88972855

Abstract: Cross-border travel often presents challenges in document storage, which can burden travelers. This study addresses the issue by designing a credential bag that enhances safety, convenience, and environmental sustainability. Utilizing design research, we applied the KANO model to categorize user needs, employed analytic hierarchy process to prioritize these needs, and used quality functional deployment to translate them into specific design elements. The KANO model has identified a total of 18 demand indicators, including “must-be”, one-dimensional, and attractive. An analytic hierarchy process analysis of the secondary indicators found that demands for the security of anti-theft, partition storage of documents, a variety of carrying methods and green sustainability have relatively high weight. The innovative solutions derived from the KANO-AHP-QFD model improve design practices and user experience in document storage. This approach offers a scientific and practical reference for the sustainable development of travel supplies and the luggage industry.

Keywords: kano model (KANO); analytic hierarchy process (AHP); quality functional deployment (QFD); cross-border travel; credential bag



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1. Introduction

China has consistently been the world’s largest source of outbound tourists, with the outbound tourism market expanding annually. The Annual Report on China’s Outbound Tourism Development (2023–2024) by the China Tourism Academy reports that outbound tourists exceeded 87 million in 2023, with a projected increase to 130 million in 2024 [1]. This growth is mirrored by a 56.9% increase in the inspection of aircraft, vessels, and vehicles [2]. As the number of outbound travelers grows, so does the demand for efficient document storage solutions. Credential bags, essential for managing travel documents, have thus garnered significant attention. Cross-border passengers need to carry a large number of relevant documents applicable to their own country and other countries when entering and leaving the country. Domestic documents include an ID card, passport, UnionPay card, driver’s license, boarding pass, domestic currency, business card, keys, etc., used to prove identity and handle relevant procedures. The documents applicable to other countries include green cards, international driving permits, foreign driver’s licenses, social security cards, foreign currencies, UnionPay cards that can be used for overseas consumption, room cards, keys, SIM cards, etc., which are used to prove identity and handle relevant procedures overseas. After arriving overseas, domestic documents are usually not usable. However, the existing credential bags are highly homogenized and only allow these documents to be passively stored in the same package, which cannot meet the needs of switching between different scenarios. Users need to carefully organize and check their documents multiple times when traveling, otherwise there may be confusion over the order of documents which could increase the risk

of loss. Designing innovative, high-quality travel storage products for users can help create an organized system, making document storage safer, more convenient, and environmentally friendly. This enhances the travel experience, drives innovation and upgrades in travel products, and promotes the sustainable development of the industry.

Despite the focus on travel storage products, there is a notable lack of innovation and significant homogenization in the market. Existing products often fail to address diverse user needs across various travel scenarios. Wu Ziyu [3] started with the three-level theory and the type spectrum analysis of cultural and creative products; this study conducts a characteristic analysis of cultural elements to identify cultural genes. Factors from genes, such as form, color, patterns, and craftsmanship, are extracted and converted into design factors. These design factors are then applied to the design of document storage bags. Gao Pei [4] explored innovative applications, such as the characteristics of theme patterns, colors, materials and stitches in Hunan embroidery elements in travel supplies. Marihi Z [5] proposed a design concept of “suitcase + obstacle monitoring + independent navigation” for aiding visually impaired air travelers. Akbar Taufan Samudra et al. [6] incorporated IoT technologies, such as microcontrollers, firebase modules, RFID tags/readers, and application to enhance the functionality of travel storage. Loth, M et al. [7] have offered recommendations on aspects such as storage and organization of travel bags to assist train travelers in enjoying both their work and travel experiences.

These studies predominantly address design aspects such as shape, material, and function, with limited focus on user needs. This study aims to address this gap by systematically investigating the functional, psychological, and aesthetic needs of credential bags for cross-border travelers. Using semi-structured interviews, participatory observation, and KANO model analysis, combined with AHP and QFD theories, this research will develop innovative designs that meet cross-border passengers’ needs, thereby enhancing document storage solutions and improving travel experiences.

2. Study Framework

2.1. Theoretical Model

The KANO model, proposed by Professor Noriaki Kano of the Tokyo Institute of Technology in 1984, is a tool for summarizing common and personalized preferences of different groups based on preference commonality measurement functions [8]. This model intuitively maps the complex relationship between product quality and consumer satisfaction [9]. It categorizes customer needs into distinct types to better understand and predict user responses, including: Must-be Needs (M), One-dimensional Needs (O), Attractive Needs (A), Indifferent Needs (I), and Reverse Needs (R) [10]. By collecting users’ initial needs through qualitative research and designing a KANO questionnaire for target users and experts, this model helps reduce product development costs and time while effectively enhancing customer satisfaction [11]. Qu Min et al. [12] used the KANO model to understand user preferences, identifying core user needs to provide effective references for medical device product development. Li YP et al. [13] applied the KANO model to focus on user needs for smartphones, determining the feasibility and added value of the product.

The Analytic Hierarchy Process (AHP), first introduced in the mid-1970s by Professor Thomas L. Saaty of the University of Pennsylvania, is a research method widely used in various decision-related fields [14]. This model divides decision-related factors into goal, criterion, and sub-criterion levels, constructing a hierarchical model and judgment matrix based on established standards. By calculating the weights of various indicators and performing consistency checks, it ultimately produces scientific evaluation results [15]. This quantitative method reduces subjectivity and improves the accuracy of prioritizing customer needs [16]. Zhou Ye et al. [17] introduced AHP into the evaluation system for semi-autonomous vehicle interaction design, indicating directions for future optimization and improvement of semi-autonomous driving interaction design. Abdelraoof Mayyas et al. [18] used AHP to assist in the selection of vehicle structural materials, balancing cost and manufacturability through ranking. Wei WJ et al. [19] combined AHP with user needs research to develop a community-based electric-vehicle-charging service design.

Quality Function Deployment (QFD), proposed by the Japanese scholars Yoji Akao and Shigeru Mizuno, is an efficient and structured strategic tool [20]. QFD theory is commonly used to map multiple relationships between user needs and technical features [21]. In the early stages of product development, designers can quantify user needs into specific design elements through the QFD model, helping developers clarify and define user requirements [22]. Dionicio Neira-Rodado et al. [23] introduced QFD to construct a Quality House and translate customer needs into product features, analyzing key design elements for hip-replacement-surgery assistance devices for the elderly and conducting design practices. Li J et al. [24] used QFD to identify key design needs, effectively guiding the innovative design of handicraft applications.

2.2. Research Framework

In recent years, numerous scholars and researchers have conducted in-depth studies on product design driven by user needs, integrating the KANO model with the AHP (Analytic Hierarchy Process). For instance, Yuzhe Qi et al. [25] applied the KANO model to identify the product requirements and priorities for health water bottles, using AHP to rank and determine the key design elements based on weightings, providing new theoretical methods and insights for related health water bottle design research. Yi XY [26] combined KANO and AHP to address the design needs of elderly patients with dementia in museum environments, aiming to guide immersive experience design and propose improvements for enhancing museum service experiences. While the KANO model captures user needs attributes, it does not assess the relative importance of these needs. The AHP method, on the other hand, accurately determines the weight coefficients of user needs, effectively ranking critical user requirements in design practice. The KANO-AHP model plays a positive role in exploring user needs during the early stages of the design process but cannot convert user needs into specific design elements. The QFD (Quality Function Deployment) model facilitates the transformation of user needs into design elements, providing more scientific decision support for design practice. Consequently, scholars have combined these three models to advance design research. For example, LiJia Yun [27] used KANO to categorize user needs, identified key requirements, calculated their weight values using AHP, and ultimately employed QFD theory with expert opinions to map user needs to specific design elements, completing an interactive design practice for the “NINIGOU” book that meets user needs. Yue Cao [28] integrated KANO, AHP, and QFD methods into the interactive design of smartwatches to address the low adaptability of current smartwatches for the elderly. However, no design studies based on this methodology for travel storage products have been reported, highlighting its research value. This study will use the KANO-AHP-QFD theoretical model to complete the design research of cross-border travel credential bags, ensuring the scientific and comprehensive nature of the product development process, with the detailed design research process illustrated in Figure 1.

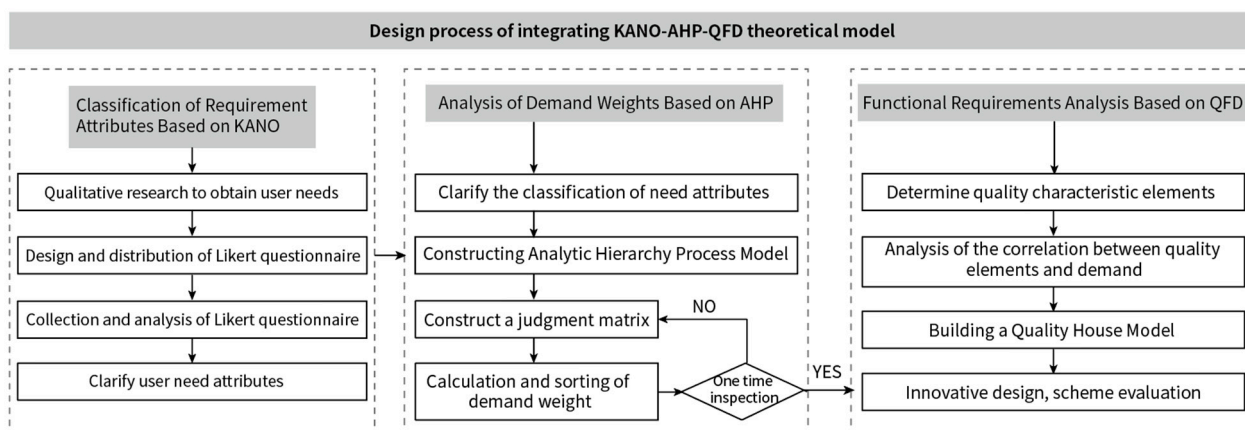


Figure 1. Design process of integrating KANO-AHP-QFD theoretical model.

3. Results

3.1. Target Users and Demand Extraction for Cross-Border Travel Credential Bags

The “China Outbound Tourism Development Report (2023–2024)” released by the China Tourism Academy indicates that the majority of outbound tourists are in the middle-aged and young demographics, with younger individuals born in the 1990s and 2000s becoming the main drivers of outbound tourism [1]. As this group’s wealth increases, their expenditure on non-essential goods has also risen, and they are more willing to pay a premium for higher-quality products. This generation, emerging alongside China’s economic reforms and the establishment of a market economy, has high expectations for both material and spiritual aspects, showing a preference for creative and well-tested products. Therefore, the primary target users for the credential bag designed in this project are young individuals aged 25–35 with outbound travel needs, with other age groups being secondary.

Based on literature review and analysis, this study focuses on a specialized survey of the young demographic with outbound travel needs, aiming to uncover their storage requirements and pain points to inform subsequent innovative design. Field research was conducted at Guangzhou Baiyun International Airport and Zhuhai Gongbei Port, which rank high in terms of national outbound and inbound passenger throughput. Observations in real scenarios facilitated the understanding of target users’ behaviors with credential bags and their storage practices. To gather richer data, semi-structured interviews were conducted with a randomly sampled group of 20 young users requiring outbound travel, made up of 8 males and 12 females. The interviews, which took a question-and-answer format, lasted no less than 40 min per participant. Participatory observation was used to record touchpoints and issues encountered by the target group with the credential bags in dynamic contexts. Initial user information was integrated to form genuine user needs, which were categorized into appearance, functionality, and psychological needs through card sorting, as detailed in Table 1.

Table 1. Initial user requirement extraction table.

Primary User Needs	Number	Secondary User Needs
Appearance needs	f1	lightweight material
	f2	sufficient capacity
	f3	rounded appearance
	f4	bright colors
	f5	fashionable design
Function needs	f6	water-resistant and tear-resistant
	f7	prevention of credit card theft
	f8	prevention of card demagnetization
	f9	SIM card storage
	f10	pen storage
	f11	separate area for coins and banknotes
	f12	easy access to boarding passes
	f13	document partitioning
	f14	intuitive item location
	f15	multiple carrying options
Mental needs	f16	efficient and convenient operation
	f17	interesting usage methods
	f18	aesthetic appeal
	f19	sustainability
	f20	enhanced security

Based on the 20 preliminary user needs extracted, a KANO dual-factor Likert questionnaire was designed, as shown in Table 2. This study used a 5-point Likert questionnaire, with five options for each question: Well Satisfied, Quite Satisfied, Doesn’t Matter, Tolerable, and Unsatisfied, with corresponding scores of 5, 4, 3, 2, and 1. Participants were asked to

rate their satisfaction with each requirement from both positive and negative dimensions. To ensure the relevance and authenticity of the research results, the survey targeted young individuals aged 25–35 who require cross-border travel. A total of 100 questionnaires were distributed, with 97 valid responses collected. The questionnaire results were classified according to the KANO evaluation results table, and K_M , K_O , K_A , K_I , K_R were computed using SPSS software (SPSSPRO 2024).

$$\begin{aligned} K_M &= \frac{M}{A+O+M+I+R}, & K_O &= \frac{O}{A+O+M+I+R}, \\ K_A &= \frac{A}{A+O+M+I+R}, & K_I &= \frac{I}{A+O+M+I+R}, \\ K_R &= \frac{R}{A+O+M+I+R} \end{aligned} \quad (1)$$

Table 2. KANO two-factor five-order Likert questionnaire.

If This Feature Is Met, Your Feeling Is (Positive Question)					User Need	If This Feature Is Not Met, Your Feeling Is (Negative Question)				
Well Satisfied	Quite Satisfied	Doesn't Matter	Tolerable	Unsatisfied		Well Satisfied	Quite Satisfied	Doesn't Matter	Tolerable	Unsatisfied
(5)	(4)	(3)	(2)	(1)		(5)	(4)	(3)	(2)	(1)
					lightweight material <i>U1</i>					
					sufficient capacity <i>U2</i>					
					rounded appearance <i>U3</i>					
					bright colors <i>U4</i>					
					fashionable design <i>U5</i>					
					water-resistant and tear-resistant <i>U6</i>					
					prevention of credit card theft <i>U7</i>					
					prevention of card demagnetization <i>U8</i>					
					...					

In the equation, M represents the proportion of must-be needs, A denotes the proportion of attractive needs, R stands for the proportion of reverse needs, O indicates the proportion of one-dimensional needs, and I reflects the proportion of indifferent needs. By calculating the membership degrees of each need, namely K_M , K_A , K_R , K_O , K_I , and categorizing them by the maximum value method, the KANO characteristics of the needs are accurately identified. Designers can use these characteristics to derive corresponding product design features, which will enhance the success rate of new product launches [29]. The 20 preliminary user needs were classified into attributes, as shown in Table 3.

Table 3. Analysis table of KANO questionnaire for cross-border travel credential bag.

Needs Elements	K_A	K_O	K_M	K_I	K_R	Needs Attributes
lightweight material	37.5%	5.0%	40.0%	17.5%	0.0%	The must-be needs (M)
water-resistant and tear-resistant	25.0%	12.5%	50.0%	10.0%	0.0%	
easy access to boarding passes	22.5%	10.0%	42.5%	22.5%	0.0%	
document partitioning	22.5%	17.5%	50.0%	10.0%	0.0%	
multiple carrying options	17.5%	7.5%	62.5%	10.0%	2.5%	
enhanced security	25.0%	12.5%	42.5%	20.0%	0.0%	
sufficient capacity	2.5%	55.0%	12.5%	30.0%	0.0%	The one-dimensional needs (O)
prevention of credit card theft	15.0%	45.0%	10.0%	30.0%	0.0%	
prevention of card demagnetization	17.5%	47.5%	10.0%	25.0%	0.0%	
SIM card storage	2.5%	57.5%	0.0%	40.0%	0.0%	
pen storage	0.0%	65.0%	0.0%	32.5%	2.5%	
separate area for coins and banknotes	2.5%	55.0%	0.0%	37.5%	5.0%	
intuitive item location	27.5%	30.0%	10.0%	27.5%	0.0%	The attractive needs (A)
sustainability	12.5%	50.0%	10.0%	25.0%	2.5%	
bright colors	47.5%	2.5%	0.0%	45.0%	5.0%	
fashionable design	55.0%	2.5%	7.5%	32.5%	2.5%	
aesthetic appeal	57.5%	5.0%	2.5%	35.0%	0.0%	The indifferent needs (I)
efficient and convenient operation	57.5%	2.5%	0.0%	37.5%	2.5%	
rounded appearance	17.5%	2.5%	0.0%	75.0%	2.5%	
interesting usage methods	27.5%	0.0%	0.0%	65.0%	2.5%	

From the results presented in Table 3, it is evident that among the 20 user needs, 6 were categorized as must-be needs (*M*), 8 as one-dimensional needs (*O*), 4 as attractive needs (*A*), and 2 as indifferent needs (*I*). No reverse needs (*R*) or questionable needs (*Q*) were identified. The must-be needs (*M*) include: lightweight material, water-resistant and tear-resistant, easy access to boarding passes, document partitioning, multiple carrying options, and enhanced security. These are key design elements for cross-border travel credential bags. Failure to meet these needs will significantly decrease user satisfaction, and while continued provision of these needs will not substantially increase user satisfaction, they remain essential and must be addressed without excessive enhancement in future practices. The one-dimensional needs (*O*) include: sufficient capacity, prevention of credit card theft, prevention of card demagnetization, SIM card storage, pen storage, separate area for coins and banknotes, intuitive item location, and sustainability. Addressing these needs effectively in cross-border travel credential bags will enhance user satisfaction, and thus, these product qualities should be maximized. The attractive needs (*A*) include: bright colors, fashionable design, aesthetic appeal, and efficient and convenient operation. Optimizing these needs will provide users with unexpected satisfaction, significantly enhancing their overall satisfaction when met. Therefore, these aspects should receive considerable attention in the design practice. The indifferent needs (*I*) include: a rounded appearance and interesting usage methods. These needs do not have a direct impact on user satisfaction and thus will not be the focus of optimization in this design practice.

3.2. Weight Analysis of Cross-Border Travel Credential Bag Demand Based on AHP

3.2.1. Constructing a Hierarchical Analysis Model for Cross-Border Travel Credential Bags

The KANO model was used to categorize the user needs for cross-border travel credential bags, but it lacked a calculation of the importance of each user need indicator. To emphasize the focus of subsequent design practices, this study introduces the AHP (Analytic Hierarchy Process) method following the KANO model analysis to accurately determine the comprehensive weight of design factors. Based on the KANO questionnaire results, 20 needs were classified into must-be needs (*M*), one-dimensional needs (*O*), attractive needs (*A*), and indifferent needs (*I*). Excluding 2 indifferent needs (*I*) that do not directly impact user satisfaction, the remaining 18 user needs were set as design objectives for developing and evaluating a cross-border travel credential bag.

A hierarchical structure model for the credential bag was established, as shown in Figure 2, consisting of three levels: goal layer, criteria layer, and sub-criteria layer. The goal layer represents the design solution for the cross-border travel credential bag, the criteria layer includes must-be needs (*M*), one-dimensional needs (*O*), and attractive needs (*A*), and the sub-criteria layer encompasses the 18 user needs, specifically: lightweight material (*M1*), water-resistant and tear-resistant (*M2*), easy access to boarding passes (*M3*), document partitioning (*M4*), multiple carrying options (*M5*), enhanced security (*M6*), sufficient capacity (*O1*), prevention of credit card theft (*O2*), prevention of card demagnetization (*O3*), SIM card storage (*O4*), pen storage (*O5*), separate area for coins and banknotes (*O6*), intuitive item location (*O7*), sustainability (*O8*), bright colors (*A1*), fashionable design (*A2*), aesthetic appeal (*A3*), and efficient and convenient operation (*A4*).

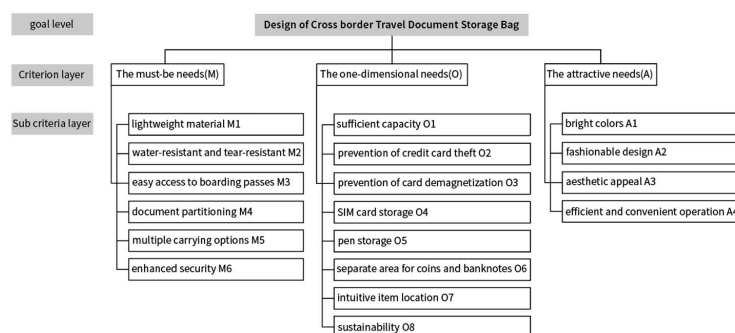


Figure 2. Hierarchical structure model of cross-border travel credential bag.

3.2.2. Calculation of User Demand Weights for Cross-Border Travel Credential Bags Based on AHP

To obtain scientifically objective results for user need weights, this study assembled a panel of 15 researchers in the design field and 5 target users. They were invited to perform pairwise comparisons of the categories of needs for the cross-border travel credential bag, using a 1–5 scale for scoring. This approach constructed a judgment matrix to determine the weights of criteria layer indicators. The geometric mean method was employed to calculate the user need weight values for the cross-border travel credential bag, and consistency checks were conducted on the matrix scores. The calculation process is outlined as follows, with results presented in Tables 4 and 5.

Table 4. Criterion level judgment matrix.

Index	The Must-Be Needs (M)	The One-Dimensional Needs (O)	The Attractive Needs (A)	Weighted Value	I_{CR}
The must-be needs (M)	1	3	5	0.6334	0.0371
The one-dimensional needs (O)	1/3	1	3	0.2605	
The attractive needs (A)	1/5	1/3	1	0.1062	

Table 5. Sub-criterion level judgment matrix.

Primary Index	Secondary Index	Judgment Matrix								Weight	Relative Weight	I_{CR}
The must-be needs (M)	lightweight material M1	1	1/3	1/2	1/4	1/3	1/4	x	x	0.0566	0.0359	0.007
	water-resistant and tear-resistant M2	3	1	2	1/2	1	1/2	x	x	0.1537	0.0974	
	easy access to boarding passes M3	2	1/2	1	1/3	1/2	1/3	x	x	0.0895	0.0567	
	document partitioning M4	4	2	3	1	2	1	x	x	0.2733	0.1731	
	multiple carrying options M5	3	1	2	1/2	1	1/2	x	x	0.1537	0.0974	
	enhanced security M6	4	2	3	1	2	1	x	x	0.2733	0.1731	
The one-dimensional needs (O)	sufficient capacity O1	1	3	3	2	2	2	1/2	1/3	0.1370	0.0357	0.009
	prevention of credit card theft O2	1/3	1	1	1/2	1/2	1/2	1/4	1/5	0.0467	0.0122	
	prevention of card demagnetization O3	1/3	1	1	1/2	1/2	1/2	1/4	1/5	0.0467	0.0122	
	SIM card storage O4	1/2	2	2	1	1	1	1/3	1/4	0.0803	0.0209	
	pen storage O5	1/2	2	2	1	1	1	1/3	1/4	0.0803	0.0209	
	separate area for coins and banknotes O6	1/2	2	2	1	1	1	1/3	1/4	0.0803	0.0209	
	intuitive item location O7	2	4	4	3	3	3	1	1/2	0.2131	0.0555	
	sustainability O8	3	5	5	4	4	4	2	1	0.3157	0.0822	
The attractive needs (A)	bright colors A1	1	4	3	2	x	x	x	x	0.4658	0.0495	0.012
	fashionable design A2	1/4	1	1/2	1/3	x	x	x	x	0.0960	0.0102	
	aesthetic appeal A3	1/3	2	1	1/2	x	x	x	x	0.1611	0.0171	
	efficient and convenient operation A4	1/2	3	2	1	x	x	x	x	0.2771	0.0294	

- (1) Establishing the comparison judgment matrix:

$$S = \begin{bmatrix} a_{11} & a_{12} & \cdots & a_{1j} \\ a_{21} & a_{22} & \cdots & a_{2j} \\ \vdots & \vdots & \ddots & \vdots \\ a_{i1} & a_{i2} & \cdots & a \end{bmatrix} \quad (2)$$

In equation: $a_{ij} \cdot a_{ji} = 1$, $i \neq j = 1, 2, \dots, n$.

- (2) Determining the weight values of requirements: The geometric mean method is introduced to the aforementioned relevant judgment matrix to accurately calculate the average value V_i of each requirement.

$$V_i = \sqrt[n]{\prod_{j=1}^n S_{ij}} \quad (3)$$

Normalization is applied to the solution results to obtain the average weight values W_1 and the weight vector W of each indicator element.

$$W_1 = \frac{\sqrt[n]{\prod_{i=1}^n S_{ij}}}{\sum_{i=1}^n \sqrt[n]{\prod_{i=1}^n S_{ij}}} \quad (4)$$

$$W = (w_1 w_2 \dots w_n)^T \quad (5)$$

- (3) $\lambda_{\max}$ represents the largest eigenvalue of each evaluation criterion, which needs to be calculated before performing the consistency check.

$$\lambda_{\max} = \frac{1}{n} \sum_{i=1}^n \frac{S_{wi}}{W_i} \quad (6)$$

In the equation: where n represents the order of the judgment matrix, S_{wi} represents the i -th component of the vector S_w .

- (4) Data validity verification: Calculate the consistency verification index I_{CI} of the judgment matrix, and the consistency ratio $I_{CR} = I_{CI}/I_{RI}$

$$I_{CI} = (\lambda_{\max} - n) / (n - 1) \quad (7)$$

In the formula, n represents the order corresponding to the matrix evaluation scale, and I_{RI} represents the average random consistency index obtained according to n .

In order to ensure the reliability of the data, the consistency of the judgment matrix must be tested. When $I_{CR} \leq 0.1$, the matrix can be regarded as meeting the consistency test requirements and the weight result is valid; otherwise, the data need to be corrected and the judgment matrix re-established.

Finally, the consistency test was conducted on the calculation results. The criterion layer $I_{CR} = 0.0371 \leq 0.1$, and the sub-criterion layers I_{CR} were 0.007, 0.009, and 0.012, all of which were less than 0.1, and passed the consistency test.

The relative weight ranking results in Table 6 indicate that, in addition to satisfying must-be needs (M), user requirements such as sustainability ($O8$) and intuitive item location ($O7$) within the category of one-dimensional needs (O), as well as bright colors ($A1$) within the category of attractive needs (A), are ranked relatively high. Therefore, in the specific design practice, it is essential to give full consideration to the highly ranked user requirements within the one-dimensional needs (O) and attractive needs (A) categories. This will significantly enhance user satisfaction with the cross-border travel credential product.

Table 6. Relative weight calculation ranking table.

Sub-Criterion Level Indicator	Relative Weight	Rank
lightweight material $M1$	0.0359	7
water-resistant and tear-resistant $M2$	0.0974	2
easy access to boarding passes $M3$	0.0567	4
document partitioning $M4$	0.1731	1
multiple carrying options $M5$	0.0974	2
enhanced security $M6$	0.1731	1
sufficient capacity $O1$	0.0357	8
prevention of credit card theft $O2$	0.0122	12
prevention of card demagnetization $O3$	0.0122	12
SIM card storage $O4$	0.0209	10
pen storage $O5$	0.0209	10
separate area for coins and banknotes $O6$	0.0209	10
intuitive item location $O7$	0.0555	5
sustainability $O8$	0.0822	3
bright colors $A1$	0.0495	6
fashionable design $A2$	0.0102	13
aesthetic appeal $A3$	0.0171	11
efficient and convenient operation $A4$	0.0294	9

3.3. Analysis of Design Elements for Cross-Border Travel Credential Bag Based on QFD

3.3.1. Mapping and Analysis of User Requirements and Design Elements

To perform Quality Function Deployment (QFD), it is necessary to first map user requirements into functional requirements and then decompose these into design elements for a cross-border travel credential bag, as shown in Table 7. Firstly, preliminary user research was conducted to obtain the design elements of the cross-border travel credential bag. Secondly, through case analysis, we refer to 12 different brands and well-known credential bags on the market to analyze product types, user needs, and design elements, as shown in Table 8. Finally, in order to provide support for subsequent design practices and ensure the objectivity and scientificity of inferred design elements, this article uses group discussion method based on user research and case analysis, and refers to the opinions of two product design professors, two product designers, and one experienced user to improve the sorted design elements. After three rounds of expert interviews, the analysis results are summarized and adjusted appropriately, and finally the determined design elements are formulated, as shown in Table 9.

Table 7. Cross-border travel credential bag initial functional requirements—design elements table.

Primary Needs	Functional Requirements	Design Elements
Appearance needs	lightweight material	Tyvek paper usage kraft paper usage nylon cloth usage PP material usage
	sufficient capacity	reasonable size multilayer separation
	bright colors	high brightness color selection high saturation color selection
	fashionable design	color contrast design multiple color scheme geometric pattern
function needs	water-resistant and tear-resistant	Tyvek paper usage Oxford cloth usage nylon cloth usage
	prevention of credit card theft	RFID shield
	prevention of card demagnetization	multi-card placeholder design one slot for one card
	SIM card storage	Sim card placeholder inside
	pen storage	pen slot inside
	separate area for coins and banknotes	special storage area
	easy access to boarding passes	specially designed storage space for airline tickets
	document partitioning	multi-division storage design
	intuitive item location	set up a transparent storage layer
	multiple carrying options	hold in hand wrist-worn crossbody
psychological needs	efficient and convenient operation	credential bag for two countries magnetic design, modular setting
	aesthetic appeal	geometrical element bright color block
	sustainability	Tyvek paper usage eco-friendly fabrics usage
	enhanced security	two countries document subcontracting storage, modular removable

Table 8. Case analysis of credential bag.

Case Analysis of Credential Bag				
Product Name	Product Image	Product Type	User Needs	Design Elements
PRADA		card holder	Small and luxurious Offline maintenance	Appearance: 8 × 13 cm, black gold, enamel logo Function: With multi-card slot, with lining Psychology: Ultimate texture, highlight taste
TUTNGEAR		credential bag	Light luxury fashion Low-key and calm	Appearance: 11 × 20 cm, monochrome color, simple design Functions: Detachable hand strap, level 5 waterproof, RFID anti-theft Psychology: Orderly arrangement, leisurely travel
Msquare		credential bag	Economical Simple shape	Appearance: 12 × 23 cm, color contrast design, multi-color optional Function: Velcro front bag, temporary storage items Psychology: Lengthening exquisite design, orderly arrangement of documents
LIHIT LAB		card holder	Lightweight material Pellucid septum	Appearance: 12 × 22 cm, special lock, fashion and light Function: PP material, strong flexibility, inner partition Psychology: Reasonable distribution of compartments, taking into account all kinds of documents
Jian Liu		credential bag	Novel fabric RFID shielding	Appearance: 14 × 23 cm, black and white color, hidden zipper Function: DuPont paper material, waterproof and tear resistant Psychology: Renewable materials, uphold the concept of environmental protection
TUMI		handbag type	Business travel Men's only	Appearance: 10 × 19 cm, clamshell design, personalized accessories Function: Small and portable, carry around Psychology: Matching scene, fashion and simple
Pacsafe		crossbody bag type	Body fit across the body Breathable material	Appearance: 12 × 22 cm, color contrast design Function: A variety of ways to carry, cross-body can be carried Psychology: Elegance and ease of travel
Aape		crossbody bag type	Fashion brand Classic IP	Appearance: 10 × 17 cm, classic camouflage Functions: With coin purse, organ inner bag Psychology: Comfortable fashion, fashion experience
Bone		neck hanging passport holder	Multifunctional storage Protect clothing to reduce friction	Appearance: 16 × 18 cm, environmentally friendly silicone, interchangeable button Functions: Can be hung on the neck can be held, SIM card storage Psychology: Small and portable, elegant
MUJI		credential bag	Flexible disassembly Transparent inner pocket	Appearance: 13 × 23 cm, a variety of models, multi-color optional Function: Transparent inner bag, intuitive and easy to find Psychology: Japanese minimalist style, low-key practical

Table 8. Cont.

Case Analysis of Credential Bag				
Product Name	Product Image	Product Type	User Needs	Design Elements
DAX		card holder	Stacked design Immediately obvious	Appearance: 9×7 cm, gradient color, magnetic buckle Function: Cash slot on the back, document partition storage Psychology: Easy access
KOKUYO		credential bag	Storage planner notebook A sense of travel ceremony	Appearance: 14×23 cm, multi-color selection Function: Can store planner notebook, documents and sundries Psychology: Add planner notebook

Table 9. User demand-design elements conversion table of cross-border travel credential bag.

User Demand-Design Elements Conversion Table			
Goal Level	Criterion Level	User Needs U	Design Elements D
design of cross-border travel credential bag	must-be needs (M)	lightweight material U_1	Based on Tyvek paper, with alloy accessories D_1
		water-resistant and tear-resistant U_2	The bag is made of Tyvek paper material D_2
		easy access to boarding passes U_3	The boarding pass storage bin is set on the outer part of the bag D_3
		document partitioning U_4	Reasonable planning of internal capacity, multi-bin storage design D_4
		multiple carrying options U_5	The credential bag can be held by hand, worn on the wrist or worn across the body D_5
		enhanced security U_6	The documents of both countries are stored separately, and the two packages can be combined into one and can be separated independently D_6
	one-dimensional needs (O)	sufficient capacity U_7	The size of the credential bag is reasonable (Using the commonly used size of 12×20 cm, the thickness of a single credential bag is about 2 cm), and the internal multi-layer division D_7
		prevention of credit card theft U_8	The bag contains an RFID shield to block RF signals D_8
		prevention of card demagnetization U_9	The bag has a multi-card design, one slot for one card D_9
		SIM card storage U_{10}	A SIM card slot is provided D_{10}
		pen storage U_{11}	A pen slot is provided D_{11}
		separate area for coins and banknotes U_{12}	There is a special area for banknotes and coins D_{12}
	attractive needs (A)	intuitive item location U_{13}	Transparent storage layer inside DP_{13}
		sustainability U_{14}	The whole bag is made of Tyvek paper, and the wrist strap and shoulder strap are made of environmentally friendly nylon fabric D_{14}
		bright colors U_{15}	The main body uses high brightness and a high saturation color, and the local uses a metal color D_{15}
		fashionable design U_{16}	A series of contrasting color designs D_{16}
		aesthetic appeal U_{17}	Uses the Memphis style pattern D_{17}
		efficient and convenient operation U_{18}	Two credential bags are magnetically absorbent D_{18}

3.3.2. Building a QFD Quality House for Cross-Border Travel Credential Bag

A Quality Function Deployment (QFD) House of Quality was constructed for the cross-border travel credential bags based on the user requirements-functionality two-dimensional matrix and the results of user requirement importance. Table 10 presents the QFD matrix, where the left wall represents user requirements and their comprehensive weights, and the roof represents the design elements. We invited an expert panel consisting of two professors specializing in product design, two product designers, and one experienced user to score the pairwise comparisons between user requirements and design elements for the cross-border travel credential bags. A score of 1.5, indicated by “●”, represents a strong correlation; a score of 1.2, indicated by “◎”, represents a moderate correlation; and a score of 1, indicated by “△”, represents a weak correlation. Blank spaces indicate no correlation. These symbols were inserted into the matrix, and the final weight of each design element was calculated as the sum of the products of all user requirements under each function and their corresponding weights [30]. The design elements were ranked according to their weights and divided into three levels, as shown in Table 11. In the design of the cross-border travel credential bags, priority should be given to the first- and second-level design elements, with the third-level design elements being considered last.

Table 10. Quality house.

User		Design Elements																	
User Need	Weight	D_1	D_2	D_3	D_4	D_5	D_6	D_7	D_8	D_9	D_{10}	D_{11}	D_{12}	D_{13}	D_{14}	D_{15}	D_{16}	D_{17}	D_{18}
U_1	0.0359	•	•																•
U_2	0.0974	•	•																•
U_3	0.0567			•						△									
U_4	0.1731			⊙	•		•	•		•	•	•	•	•	⊙				
U_5	0.0974					•											△		
U_6	0.1731					•	•		•						•				
U_7	0.0357			△	⊙		⊙	•		⊙	△	△	△	△	⊙				
U_8	0.0122								•										
U_9	0.0122				⊙			△		•									
U_{10}	0.0209				•			⊙		⊙	•								
U_{11}	0.0209				•			⊙		⊙		•							
U_{12}	0.0209				•			⊙		⊙			•						
U_{13}	0.0555			•	•		•	⊙		⊙	•	•	•	•	•		△	△	
U_{14}	0.0822			•	•		•	△		△	△	△	△	△	•		△		
U_{15}	0.0495	△	△																
U_{16}	0.0102	⊙	⊙			⊙	△								⊙	•	⊙	⊙	•
U_{17}	0.0171					△										⊙	•	•	⊙
U_{18}	0.0294	•	•																•
Weight factor		0.3058	0.3058	0.5350	0.6177	0.5173	0.7789	0.5494	0.2780	0.6015	0.4922	0.4922	0.4922	0.4608	0.7290	0.1101	0.3355	0.1528	0.2799
Rank		11	11	6	3	7	1	5	13	4	8	8	8	9	2	15	10	14	12

Table 11. Design elements sorting table.

Design Elements Sorting Table			
Level	Criterion Level	Design Elements	Rank
one-level	M	The documents of both countries are stored separately, and the two packages can be combined into one and can be separated independently DP_6	1
	O	The whole bag is made of DuPont paper, and the wrist strap and shoulder strap are made of environmentally friendly nylon fabric DP_{14}	2
	M	Reasonable planning of internal capacity, multi-bin storage design DP_4	3
	O	The bag has a multi-card design, one slot for one card DP_9	4
	O	The size of the credential bag is reasonable (using the commonly used size of 12 * 20 cm, the thickness of a single credential bag is about 2 cm), and the internal multi-layer division DP_7	5
second level	M	The boarding pass storage bin is set on the outer part of the bag DP_3	6
	M	The credential bag can be held by hand, worn on the wrist or worn across the body DP_5	7
	O	A SIM card slot is provided DP_{10}	8
	O	A pen slot is provided DP_{11}	8
	O	There is a special area for banknotes and coins DP_{12}	8
	O	Transparent storage layer inside DP_{13}	9
	A	A series of contrasting color designs DP_{16}	10
	M	Based on Tyvek paper, with alloy accessories DP_1	11
	M	The bag is made of Tyvek paper material DP_2	11
three-level	A	Two credential bags are magnetically absorbent DP_{18}	12
	O	The bag contains an RFID shield to block RF signals DP_8	13
	A	Using the Memphis style pattern DP_{17}	14
	A	The main body uses strong brightness and strong saturation color, and the local uses a metal color DP_{15}	15

4. Discussion

With the progression of time, the communication and mobility of international personnel have intensified. Over several decades, credential bags have undergone development, resulting in the establishment of stable design, production, and manufacturing processes. However, this has also led to significant product homogenization in the market, severely constraining the sustainable development of the travel goods and luggage industry. As shown in Table 8, in terms of appearance, although there are various design styles for credential bags on the market, their overall recognition is low and they do not have any memory points. In terms of functionality, its function, material, and structure are relatively stable, and different types of documents are stored in the same bag. The materials are mostly PVC, non-woven fabric, Oxford cloth, etc. With the development and application of new materials, there is a lack of new requirements and attempts in terms of materials. In terms of the psychological dimension, its user base is relatively fixed, often ignoring the needs of users in different scenarios.

This study starts from the needs of users who need to enter and exit the country in different scenarios, and based on the 18 design elements in Table 11, designs a credential bag that can optimize the user experience of entry and exit personnel, as shown in Figures 3–9.

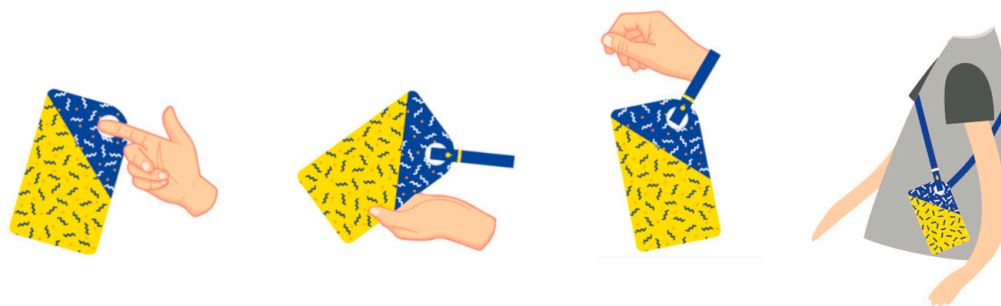


Figure 3. How to carry the cross-border travel credential bag.



Figure 4. Color display of cross-border travel credential bag.



Figure 5. Physical display of cross-border travel credential bag.

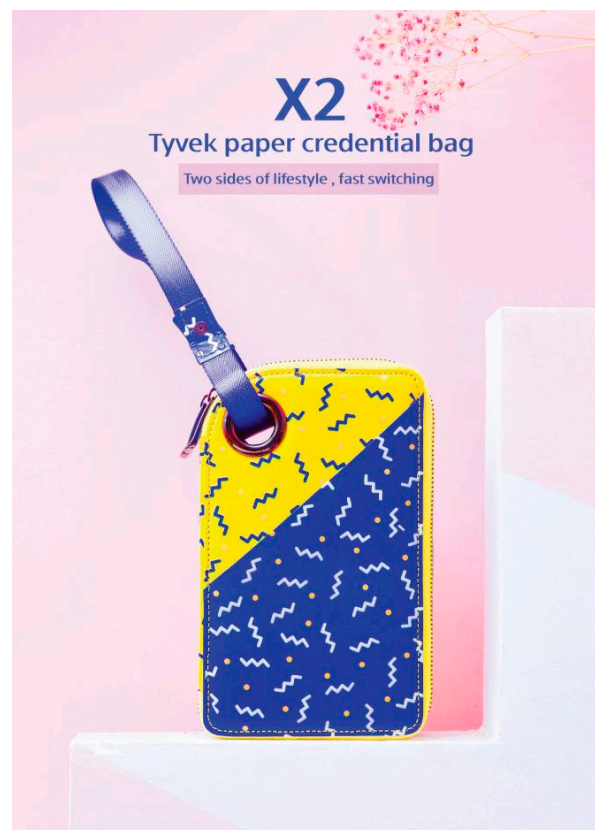


Figure 6. Rendering of cross-border travel credential bag.



Figure 7. Exhibition board for cross-border travel credential bag design.



Figure 8. Display of design elements for cross-border travel credential bag.



Figure 9. Scene diagram of cross-border travel credential bag.

4.1. Conceptual Design of Cross-Border Travel Credential Bag Driven by User Demand

This paper focuses on the study of user requirements for documents in cross-border travel scenarios and proposes the following concepts and innovations for the design of a cross-border travel credential bag:

- (1) A modular design featuring a combination-splitting approach is proposed, allowing for the separate yet integrated storage of domestic and foreign documents (the two compartments can be combined into one or separated independently). Before departure, the two credential bags are magnetically attached. Upon arrival abroad, the domestic credential bag can be detached and stored appropriately, depending on the change in scenarios between domestic and international environments. This modular design not only helps travelers maintain order but also meets the varying needs of users in different scenarios, making document storage safer, more convenient, and efficient during travel.
- (2) Various usage states of the credential bag have been carefully considered. The inclusion of eyelet components enhances the breathability of the bag and provides multiple carrying options, such as handheld, finger looped through the eyelet, wrist-hanging and crossbody.
- (3) The aesthetic preferences of young travelers have been taken into account by incorporating Memphis design elements, which have recently gained popularity among younger demographics. This design choice highlights user individuality and enhances product recognition.

4.2. Modelling Design of Cross-Border Travel Credential Bag Driven by User Demand

- (1) Modeling design: The product features a minimalistic, rounded geometric design language. Ergonomics are emphasized through the chamfering of the eyelet locations, enhancing comfort and safety during use. The product is available in multiple color options, with carefully selected high-saturation contrasting colors to enhance the overall vibrancy and dynamism of the cross-border travel credential bag. The combination of a simple form with expressive Memphis pattern elements is crucial for conveying the product's energetic, youthful, and fashionable appeal. The dimensions of the credential bag are 20 cm in height and 12 cm in width, providing a balanced proportion and ample capacity to effectively meet users' practical needs, thereby optimizing the user experience.
- (2) Multi-compartment storage design: The internal structure is thoughtfully organized to classify and allocate space for the various documents required during cross-border

travel. It includes slots for cards, passports, pens, SIM cards, a dedicated cash storage area, and a transparent storage layer. The multiple internal compartments, with each card having its designated slot, help prevent card demagnetization. An exterior compartment is provided for boarding pass storage, enabling quick access for smooth passage through checkpoints.

- (3) **Material selection:** The main body of the bag is made from DuPont paper, known for its fine, lightweight texture, water resistance, and tear resistance. This material is environmentally friendly, recyclable, and compatible with most digital printing technologies, making it suitable for various processing techniques. Electroplated metal is used for components such as eyelets, zipper pulls, and zippers, offering a high-quality luster, durability, and resistance to wear and fading, while also being lightweight—a common choice for bag accessories. The wrist and shoulder straps are made from eco-friendly nylon fabric that is durable, water-resistant, dustproof, and washable, contributing to the extended lifespan of the credential bag.
- (4) **RFID Radio frequency identification:** The product incorporates RFID-blocking lining to effectively shield against electromagnetic radio frequency scanning within a 2-meter range, which could otherwise read card chips and steal personal information. This feature builds a secure barrier, protecting personal information and assets from theft and preventing card demagnetization.

5. Conclusions

Amid the surge in cross-border travel, innovative design of cross-border travel credential bags can effectively address the current issues of homogeneous product design, limited styles, and lack of innovation in design concepts. In previous product practices, there has been an overemphasis on basic functionality, with relatively vague user targeting, often overlooking the comprehensive consideration of users, scenarios, and needs. This neglect of special requirements within user segmentation has resulted in products that fail to deliver a superior travel experience. This article is guided by user needs and constructs a product design and development process that integrates the KANO–AHP–QFD model. It innovatively designs cross-border travel document packages from three aspects: appearance, functionality, and psychology. This article divides user demand attributes and ranks them by weight, and then transforms important user demands into specific design elements through QFD, ensuring the scientific and rational design of cross-border travel document storage bag products. At the same time, the design process adopted in this article can also provide new ideas and references for product development driven by other user needs. Although cross-border travel document storage bags can solve some practical problems for cross-border travelers, for the entire complex and huge travel scenario, selecting segmented groups, considering more scenarios and personalized needs can expand the research space for future travel storage products. The different user needs arising from differences in policies, technology, culture, etc., in the future, the coordination between product personalization and universal design needs, and the usage needs of users with various special family structures, still leave huge room for improvement in this mature market.

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