

# INTEGRATING KANO MODEL WITH ROUGH SET THEORY TO DETERMINE USERS' NEEDS: IMPROVING SERVICE QUALITY IN ACADEMIC LIBRARIES IN CHINA

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## ABSTRACT

*Libraries have been valued as the heart of university due to their vital functions, which include knowledge sharing and retention, communication, education, and recreation. In the digital stage, library services tend to be more intelligent and diverse. However, there has not been an essential improvement in the service quality of academic libraries, as users' needs and expectations have not been appreciated by researchers. To address the issue, the authors proposed a robust method that integrates the Kano Model with the Rough Set Theory, aiming to improve library service quality based on users' needs. Thus, fourteen stakeholders were invited for a user interview to explore the existing library services situation. Then, surveys of more than three hundred were conducted to solidify the research findings. Twenty users' needs were identified during this process, and they are subsequently classified into Kano attributes. After that, the authors employed the Rough Set Theory to prioritize these needs, and the five most influential needs were identified. Here, the service touchpoints analysis was carried out to link users' needs, users' behavior, service processes and practical design schemes. Finally, the authors discussed design strategies for improving the quality of service in academic libraries. It was verified that the integration of the Kano Model and Rough Set Theory was able to show advantages in exploring users' needs for service quality improvement in academic libraries. As a consequence, this article could also serve as a reference for applying users' needs-driven design approach in other fields.*

**Keywords:** Kano Model; Academic libraries; Service design; Rough Set Theory

## 1. INTRODUCTION

### 1.1 Background

Technological advancement has resulted in robust changes in the functions and modes of academic libraries through the adoption of emerging technologies, making them move towards a more intelligent and diverse direction (Wang et al., 2020). These technologies can expand the service modes of traditional libraries and improve their service effectiveness and efficiency. In modern society, users can access library services through different methods, such as smart terminals, social media platforms, websites and mobile applications (Yoon, 2016; Choi & Rasmussen, 2009; Madhusudhan & Nagabhushanam, 2012). In China, "Chaoxing," a mobile library application, provides various library services for university students, through which users can access digital information, reserve seats, search for books and share their recent readings with others (Hu & Zhang, 2016). Nalluri & Gaddam (2016) also noted that academic libraries could allow remote users to access electric journals and other digital resources, regardless of their geographic locations. These digital techniques have been widely applied in academic libraries worldwide, changing the way users interact with libraries.

### 1.2 Problem Statement

Although digital technologies allow users to approach more functions of library services, there is still a long way to go to improve library service quality. It is unsure whether the rapid changes in libraries could result in the improvement of service quality. In effect, various problems are existing in the current situations of library service. According to Li et al. (2019), two major problems identified are; first, traditional digital libraries do not pay sufficient

attention to users' expectations and interests because they only function as a source provider. Second, massive information and functional access can make information overload problems more prominent due to user information and time cost limitation. This is reflected in the diverse and complicated functions of library phone applications, online digital libraries, and smart library terminals. Additionally, previous studies indicated that library services in China are still subpar compared to their counterparts in developed nations (Chen et al., 2018). These issues cannot be negligible since they have negative impacts on library service quality.

As "service quality," "satisfaction," and "users' expectation" are often interrelated and used interchangeably, it is essential to focus on users' needs to improve library service quality (Dahan et al., 2016). Besides, some researchers also posed that libraries have to identify and measure users' perceptions and needs since they constitute a fundamental section in defining service quality (Pedramnia et al., 2012; Shueb, 2011). Cristobal (2018) illustrated robust correlations among users' needs, satisfaction, and library service quality. Gómez-Cruz et al. (2020) also deemed that great concern should be given to users' opinions to help libraries adapt to new realities. In this regard, studies aiming at users' expectations and needs are both necessary and meaningful for scholars in library research and design research areas.

### 1.3 Research Objective and Research Questions

As library services are complicated and diverse, this article only focuses on a specific part of library services, namely the borrowing service. The main reason is that the borrowing service is a fundamental part of library services, which directly impacts the quality of service in academic libraries. On the other hand, library borrowing services face rapid change and challenges due to the high demands of users, application of digital technology, and multiple sources of information (such as Library mobile applications, Library websites, and intelligent terminals). Three research questions are posed: First, what is the existing situation of borrowing services in academic libraries? Second, what are users' perceptions and needs towards library borrowing services? Third, how to apply users' needs to improve library service quality? This study aims to identify the existing situation of library borrowing services and users' needs and expectations of academic libraries. A robust approach is employed by integrating the Kano Model with the Rough Set Theory to gain users' perceptions and needs on library borrowing services. Then, the final objective is to develop a user-oriented tool that can classify and prioritize users' needs in a systematic way, resulting in improving the library service quality.

This article is organized into six sections. In the first section, research backgrounds and problems are given, followed by a literature review. Section two presents an overview of the library service research, integrating the Kano Model and Rough Set Theory. Later, the authors discuss the research method and research design. In section four, a case study of borrowing services in Chinese academic libraries is conducted before the findings are discussed in section five. Finally, the research is concluded in section six.

## 2. LITERATURE REVIEW

### 2.1 Library Service Research

Service design is a multidisciplinary research that involves marketing, human resources, operations, organizational structure, and technologies (Bitner et al., 2008). It has penetrated various fields in the past few decades, including library areas. In effect, libraries are also regarded as a set of services within a highly integrated system which shared an insight into the process and benefits (Marquez & Downey, 2015). Studies related to library service have attracted extensive attention recently. Johnson et al. (2015) conducted a participatory design to investigate users' needs and existing aesthetics of library services. Service path journey and prototype pattern detection were employed in Hunt Library's research, making Hunt Library highly appreciated by the public (Carr, 2017). In the Stanford University Library (USA), service design studios were set up to create character models (Carvalho & Goodyear, 2018). A number of British public libraries adopted various practices and services to benefit vulnerable groups, reflecting humanistic concerns and universal design principles (Freeman, 2017). In addition, some innovative concepts and models of library services have been forwarded by scholars. A "Triangle" service model was developed in the University of Queensland Library, enabling librarians' skill set to expand in the areas of research support and digital scholarship (Brown, 2018). Similarly, "Ubiquitous Library" emerged as a novel service mode in recent years, where users can approach knowledge service and resources in libraries, regardless of physical constraints (Wang, 2019). These studies have explored innovative service patterns and modes of libraries, but rarely do they concentrate on users' perceptions and expectations related to library service quality.

### 2.2 Kano Model

The Kano Model is a popular tool for the product development process, which was created to reveal the relationships between users' needs and users' satisfaction (Kano, 1984). Based on the Kano Questionnaires, respondents are

required to choose one of the following linguistic terms for a need, including “very satisfied,” “satisfied,” “neutral,” “not too satisfied,” and “unsatisfied,” with respect to two opposite cases: one is “if the need is fulfilled” while the other is “if the need is not fulfilled,” as shown in Table 1 (Wang & Wang, 2014). The combination of answers in two cases can be categorized into a type of Kano attributes, including “Attractive” attributes,” “One-dimensional” attributes, “Must-be” attributes, “Indifferent” attributes, and “Reverse” attributes (Table 2). For instance, a user gets very satisfied if their need is fulfilled, he or she gets satisfied even if their need is not fulfilled. In this case, the need can be defined as an “Attractive attribute.” Notably, suppose a respondent gives the same answer for very satisfied or very dissatisfied to a need, regardless of whether it is fulfilled. In that case, we can define this need as a “Questionable” (Q) answer as it is invalid and cannot be mapped to any type of Kano attributes.

According to formula (1), different attribute values can be calculated. The Kano attributes related to a need which could be determined with the largest proportion as the qualitative basis (Dace et al., 2019). (Among them,  $K_M$ ,  $K_O$ ,  $K_A$  and  $K_I$  represent the proportion of M, O, A, and I attributes, respectively). Additionally, Q attributes and R attributes represent questionable results and reverse attributes, respectively, which should be removed since they contribute nothing or result in negative effects to user satisfaction.

| Question                     | Very Satisfied | Satisfied | Neutral | Dissatisfied | Very Dissatisfied |
|------------------------------|----------------|-----------|---------|--------------|-------------------|
| If the need is fulfilled     |                |           |         |              |                   |
| If the need is not fulfilled |                |           |         |              |                   |

Table 1: Kano questionnaire

|                          |                   | If the need is not fulfilled |           |         |              |                   |
|--------------------------|-------------------|------------------------------|-----------|---------|--------------|-------------------|
|                          |                   | Very Satisfied               | Satisfied | Neutral | Dissatisfied | Very Dissatisfied |
| If the need is fulfilled | Very satisfied    | Q                            | A         | A       | A            | O                 |
|                          | Satisfied         | R                            | I         | I       | I            | M                 |
|                          | Neutral           | R                            | I         | I       | I            | M                 |
|                          | Dissatisfied      | R                            | I         | I       | I            | M                 |
|                          | Very Dissatisfied | R                            | R         | R       | R            | Q                 |

Table 2: Kano attributes evaluation table

Formula 1

$$K_M = \frac{M}{M+O+A+I} \quad K_M = \frac{M}{M+O+A+I} \quad K_O = \frac{O}{M+O+A+I} \quad K_O = \frac{O}{M+O+A+I}$$

$$K_A = \frac{A}{M+O+A+I} \quad K_A = \frac{A}{M+O+A+I} \quad K_I = \frac{I}{M+O+A+I} \quad K_I = \frac{I}{M+O+A+I}$$

These five types of Kano attributes are described as follows (Figure 1):

- Attractive attributes (A): The fulfillment of attractive attributes will result in a rapid increment in users’ satisfaction, while the absence of them does not significantly affect users’ satisfaction.
- One-dimensional attributes (O): They have linear relations with users’ satisfaction, so they should be fulfilled as much as possible.
- Must-be attributes (M): They are related to users’ fundamental needs, and a lack of them would worsen user satisfaction dramatically. However, the increase of them only satisfies users a bit.
- Indifferent attributes (I): They do not impact users’ satisfaction anymore, whether they increase or decline.
- Reverse attributes (R): The fulfillment of reverse attributes will upset users, so they are often removed.

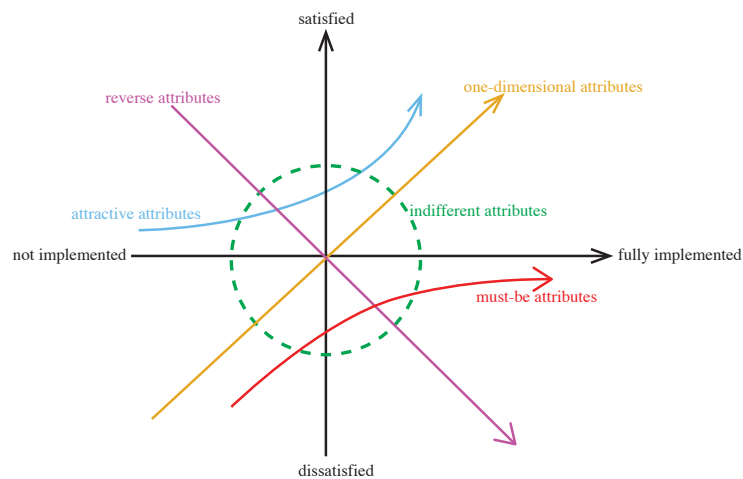


Figure 1: Kano Model (Adapted from (Kano, 1984))

The Kano Model is a valuable tool to qualify users' needs and satisfaction in many studies. Luor et al. (2015) explored significant factors affecting the manufacture and design of smart household appliances based on the Kano Model and Kano Map that were applied to categorize patients' demands in a public hospital in Iran (Shahin & Akasheh, 2017). Additionally, many scholars have a stronger interest in combining the Kano Model with other approaches. Hartono (2016) integrated Kansei Engineering, Kano, and TRIZ to investigate people's cultural needs from diverse backgrounds. Pai (2018) combined the Kano Model with the Importance-Performance Analysis (IPA) and applied it to identify service attributes in the chain restaurant industry. Chen et al. (2018) combined the refined Kano Model and the Quality Function Deployment (QFD) method, revealing that providing limited offers (due to periods, seasons, and regions) should be the top priority for improving the healthy food service industry.

### 2.3 Rough Set Theory

Rough Set Theory is a data analysis method developed in 1982 by Pawlak (1998) where it could analyze and represent the data set from an objective point of view. In the data preparation process, the Rough Set Theory can perform dimensionality reduction operations on the data set. In the data statistics process, this approach can calculate the weight of individual features in the whole data set and prioritize them (Thangavel & Pethalakshmi, 2009). Below are the following definitions about Rough Set Theory:

**Definition 1:** Let  $\mathcal{S} = (U, A, V, f)$   $\mathcal{S} = (U, A, V, f)$  be a knowledge decision system, where  $U$  is a non-empty and finite set of objects (the universe),  $U = (X_1, X_2, \dots, X_n)$ ,  $U = (X_1, X_2, \dots, X_n)$ .  $A = C, D$  is the non-empty finite set of attributes,  $C \cap D = \emptyset$   $C \cap D = \emptyset$ , the subsets  $C$  and  $D$  represent conditional attributes and decision attributes, respectively.  $V = U_{a \in A} V = U_{a \in A} V_a$  is the set of attribute values, which represents the value range of attribute  $a \in A$   $a \in A$ .  $f: U \times A \rightarrow V$   $f: U \times A \rightarrow V$  is the Information function, which maps each object  $X$ 's attribute value in  $U$ .

In a knowledge decision system, if one attribute is removed without causing a collapse of the equivalence-class structure, this attribute has nothing to do with the decision system (Jia et al., 2016).

**Definition 2:** For any  $C_j \in C$   $C_j \in C$ , if  $POS_C(D) = POS_{(C-C_j)}(D)$   $POS_C(D) = POS_{(C-C_j)}(D)$ , then  $C_j$  is an unnecessary attribute that can be removed from conditional set  $C$ . If  $POS_C(D) \neq POS_{(C-C_j)}(D)$   $POS_C(D) \neq POS_{(C-C_j)}(D)$ , then  $C_j$  is a necessary attribute.  $Core(C)$   $Core(C)$  is a set of all necessary attributes.

**Definition 3:** In a decision system, usually, the significance of one attribute is determined by the change of the dependency (Jia et al., 2016).

In the non-empty finite set  $A$ , the dependence of the decision attribute  $D$  on the conditional attribute  $C$  is defined as

$$k = \beta_C(D) = \frac{|POS_C(D)|}{|U|}$$

**Definition 4:** In the set of conditional attribute  $C$ , the significance of one attribute  $C_j, C_j \in C$  is defined as

$$Sig(C_j) = \frac{\beta_C(D) - \beta_{C-C_j}(D)}{\beta_C(D)} = 1 - \frac{\beta_{C-C_j}(D)}{\beta_C(D)} = 1 - \frac{|POS_{(C-C_j)}(D)|}{|POS_C(D)|}$$

Moreover, the Rough Set Theory has been widely used as a quantitative tool in various fields. Chen and Tsai (2016) applied it for weight calculation for selecting suitable locations in a restaurant chain. This approach can also describe the relations among the data set, such as exploring the spatiotemporal relations of eutrophication in China's Da'ning River (Yan et al., 2016). In some cases, the Rough Set Theory can be combined with other research methods. Liou et al. (2016) integrated the Rough Set Theory into a flow graph approach and identified several service attributes strongly related to users' satisfaction in the airline industry. Besides, some scholars applied the Rough Set Theory to improve the existing algorithm. Pacheco et al. (2017) proposed a new unsupervised algorithm for feature selections based on a refined Rough Set Theory and computed similarities between features for fault diagnosis in rotating machinery.

### 2.4 The Proposed Integrated Approach

In this article, the authors propose a robust approach that integrates the Kano Model with the Rough Set Theory, aiming to investigate users' needs from academic libraries to improve the quality of service. The Kano Model has shown advantages in revealing relationships between users' needs and users' satisfaction (Luor et al., 2015). Generally, it provides a framework that enables eliciting users' needs and expectations, which can ulteriorly improve users' satisfaction and service quality when these needs are met (Xu et al., 2019). Although the Kano Model can allow the classification of two-dimensional service attributes, this method is not enough to boost user satisfaction (Ma et al., 2019). The main reason is that the Kano Model only allows a qualitative evaluation of product attributes and users' needs, which cannot precisely represent the degree to which the users are satisfied (Wassenaar et al., 2005; Berger et al., 1993). Hence, it is necessary to introduce a quantitative approach to improve the accuracy and uncertainty of the Kano Model. In our research,

the Rough Set Theory is employed to provide quantitative assessments for user satisfaction. The weight of product attributes is expected to be calculated and determined by this approach. In effect, the Rough Set Theory has proved to be an effective tool for quantitative determination in the previous findings. (Zheng et al., 2017; Zhao et al., 2020).

### 3. METHODS

As Shoeb (2011) noted, it is necessary to understand what users expect and need concerning library service quality for better management. In this regard, the research explores the current situation of library service and users' needs and perceptions, to improve library service quality and users' satisfaction. This section gives a detailed description of the methods employed in each step, as shown in Figure 2.

#### 3.1 The Sampling Sites and Population

Several academic libraries in Bengbu and Hefei, China, are selected as sampling sites. As a previous study suggested, although China has a large number of public libraries, the service quality is still relatively subpar than those in developed countries (Chen et al., 2018). In this regard, China's context provides a viable laboratory for researchers to examine users' needs and perceptions of library service quality. The university students, university teachers, library staff, and designers are selected as respondents since design activities often require the collaboration of people from diverse backgrounds (Kamarudin et al., 2015).

#### 3.2 User Interview

An interview on academic library users was conducted to identify users' perceptions and needs for the current situation of library borrowing service. In total, fourteen participants were invited to carry out a user interview, comprising eight university students, three university teachers, and three librarians. The sample size of this study is in line with the previous best practice literature. As Baker et al. (2012) stated, a sample of between six to twelve respondents for interviews can offer valuable findings and represent adequate research numbers.

#### 3.3 Questionnaire Survey Based on the Kano Model

This step attempts to classify users' needs into different Kano attributes. As many as one hundred and two questionnaires were distributed in several academic libraries in Bengbu and Hefei. Questionnaires with unreasonable and incomplete answers were removed, and a total of seventy-eight valid

questionnaires were recovered. The questionnaire contained two parts; the first part was designed to obtain respondents' demographic information, such as genders, age groups, occupations, and frequency of visiting libraries. The second part was designed to assess users' needs based on a Kano questionnaire.

#### 3.4 Questionnaire Survey Based on the Rough Set Theory

This step aims to prioritize the remaining needs through the Rough Set Theory, during which the core needs are identified. Researchers surveyed thirteen academic libraries in Bengbu and Hefei. Three hundred questionnaires were distributed to users in these places, with two hundred and forty-one valid answers received, eventually. During the survey, informants were required to evaluate their experiences and perceptions for these libraries via a five-level Likert Scale to construct a decision table.

#### 3.5 Service Touchpoints Analysis

Service touchpoints are the connection points between service providers and users. There are various types of touchpoints in service processes containing languages, products, objects, environments, etc. (Touloum et al., 2018). The analysis of service touchpoints can provide a comprehensive understanding of relationships between users' needs and practical design (Kronqvist & Leinonen, 2019). In this study, the service touchpoints analysis is conducted to link users' needs, behavior, and practical design schemes, corresponding to the third research question: how to apply users' needs to improve library service quality?

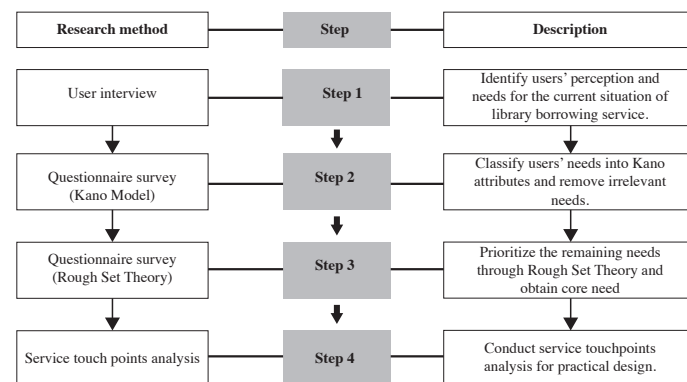


Figure 2: The research design framework

## 4. RESULT

### 4.1 Users Perceptions Towards Existing Situations of Library Service

Through the user interview, the authors found that some users preferred to use public computers in libraries for book retrieval, while others were willing to use mobile applications to search for information. The informants also stated that mobile applications were extensively welcomed because they can be carried easily and used at any time and place. Moreover, the informants had some common problems, such as being unfamiliar with the borrowing process, finding books, and consultations. A flow chart is drawn to represent the result (Figure 3). A total of twenty users' needs are subsequently summarized in Table 3.

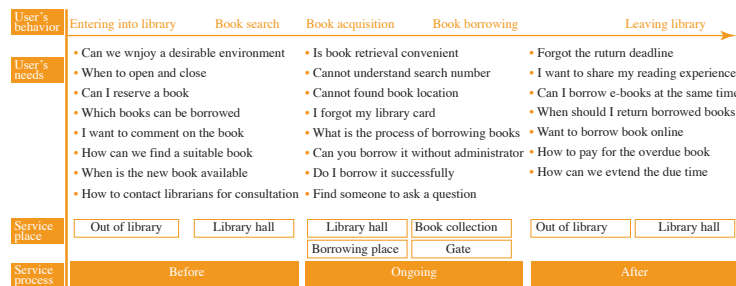


Figure 3: Library Borrowing Process

| Before |                       | Ongoing |                          | After |                    |
|--------|-----------------------|---------|--------------------------|-------|--------------------|
| No.    | Users' needs          | No.     | Users' needs             | No.   | Users' needs       |
| 1      | Desirable environment | 7       | New book information     | 15    | Expire remind      |
| 2      | Service time notice   | 8       | Book retrieval           | 16    | Experience sharing |
| 3      | Book reservation      | 9       | Book position            | 17    | Returning services |
| 4      | Borrowing authority   | 10      | Route guidance           | 18    | Extension request  |
| 5      | Book recommendation   | 11      | Electronic certification | 19    | Book notes         |
| 6      | Consultation          | 12      | Process guidance         | 20    | Book preservation  |
|        |                       | 13      | Self-service             |       |                    |
|        |                       | 14      | Electronic books         |       |                    |

Table 3: Users' needs summary.

### 4.2 Users' Needs Classification through Kano Model

Based on the Kano Model, twenty users' needs were categorized into five types of Kano attributes: "M attributes" include book retrieval and consultation, "O attributes" include book recommendation, self-service, and new book information. Meanwhile, "A attributes" include route guidance, process guidance, electronic certification, and experience sharing, and book reservation (Table 4). However, "I attributes" and "R attributes" are removed since they are not relevant to users' satisfaction.

| Must-be Attributes<br>( $K_M K_M$ ) | One-dimensional<br>Attributes ( $K_O K_O$ ) | Attractive Attributes<br>( $K_A K_A$ ) |
|-------------------------------------|---|--|
| $C_1$ Book retrieval                | $C_3$ Book recommendation                   | $C_6$ Route guidance                   |
| $C_2$ Consultation                  | $C_4$ Self-service                          | $C_7$ Process guidance                 |
|                                     | $C_5$ New book information                  | $C_8$ Electronic certification         |
|                                     |   | $C_9$ Experience sharing               |
|                                     |   | $C_{10}$ Book reservation              |

Table 4: The remained needs

### 4.3 Weight Calculation through Rough Set Theory

#### 4.3.1 Constructing Decision Table

A decision table was constructed according to the collected data set (Table 5). In the decision table, "U" represents the thirteen sample university libraries, conditional attribute "C" represents the ten remained users' needs, and decision attribute "D" represents the service experience level of each library, respectively. Notably, as the data is continuous, meanwhile the Rough Set Theory can only deal with discrete data set, it is necessary to discretize them (Shu & Qian, 2015). The discretization method is: the evaluation level of the interval [1, 3.5] is defined as 1; the evaluation level of the interval [3.5, 5.5] is defined as 2; the evaluation level of the interval [5.5, 7.0] is defined as 3 (Figure 4).

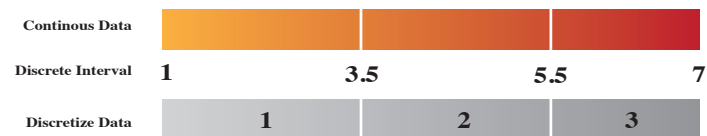


Figure 4: The Evaluation Level of Interval



| U               | C <sub>1</sub> | C <sub>2</sub> | C <sub>3</sub> | C <sub>4</sub> | C <sub>5</sub> | C <sub>6</sub> | C <sub>7</sub> | C <sub>8</sub> | C <sub>9</sub> | C <sub>10</sub> | D |
|-----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|-----------------|---|
| U <sub>1</sub>  | 3              | 3              | 2              | 2              | 2              | 2              | 1              | 2              | 2              | 2               | 3 |
| U <sub>2</sub>  | 3              | 1              | 2              | 2              | 2              | 2              | 1              | 2              | 2              | 2               | 2 |
| U <sub>3</sub>  | 2              | 2              | 3              | 2              | 2              | 2              | 1              | 2              | 2              | 2               | 2 |
| U <sub>4</sub>  | 2              | 1              | 1              | 1              | 1              | 2              | 2              | 1              | 2              | 1               | 1 |
| U <sub>5</sub>  | 3              | 2              | 2              | 2              | 2              | 2              | 1              | 2              | 2              | 2               | 2 |
| U <sub>6</sub>  | 2              | 1              | 1              | 2              | 1              | 2              | 2              | 1              | 2              | 1               | 2 |
| U <sub>7</sub>  | 3              | 2              | 3              | 2              | 2              | 2              | 1              | 2              | 2              | 2               | 3 |
| U <sub>8</sub>  | 1              | 2              | 1              | 1              | 2              | 1              | 2              | 1              | 2              | 1               | 1 |
| U <sub>9</sub>  | 3              | 2              | 2              | 2              | 2              | 2              | 3              | 3              | 2              | 2               | 2 |
| U <sub>10</sub> | 1              | 2              | 1              | 2              | 3              | 3              | 3              | 1              | 3              | 2               | 3 |
| U <sub>11</sub> | 3              | 2              | 1              | 1              | 2              | 1              | 2              | 1              | 2              | 1               | 2 |
| U <sub>12</sub> | 1              | 2              | 1              | 2              | 3              | 1              | 3              | 1              | 3              | 2               | 1 |
| U <sub>13</sub> | 3              | 2              | 3              | 2              | 2              | 2              | 3              | 3              | 2              | 2               | 3 |

**Table 5:** Decision table

### 4.3.2 Prioritizing Users' Needs

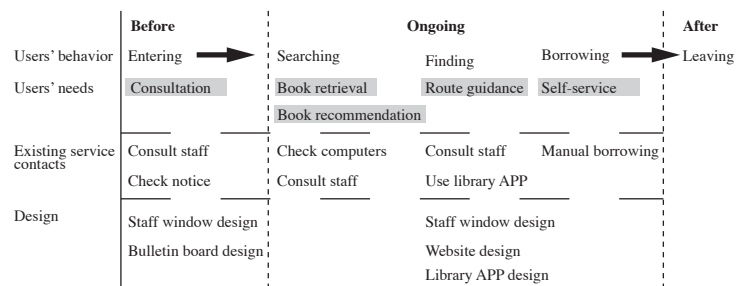
The weight of users' needs was calculated based on the Rough Set Theory. Five core needs were identified eventually, the weights and ranking of which were summarized in Table 6. It can be derived that book retrieval is the most important need, receiving a comprehensive weight of 0.3079. Consultation has a weight of 0.2307, which is at the second position. Book recommendation, route guidance, and self-service are equivalently essential and have a weight of 0.1538. Therefore, researchers should give priority to these five needs to improve the service quality of academic libraries.

| Users' needs        | Kano attributes            | Comprehensive weight | Ranking |
|---------------------|----------------------------|----------------------|---------|
| Book retrieval      | Must-be attributes         | 0.3079               | 1       |
| Consultation        |                            | 0.2307               | 2       |
| Book recommendation | One-dimensional attributes | 0.1538               | 3       |
| Self-service        |                            | 0.1538               | 3       |
| Route guidance      | Attractive attributes      | 0.1538               | 3       |

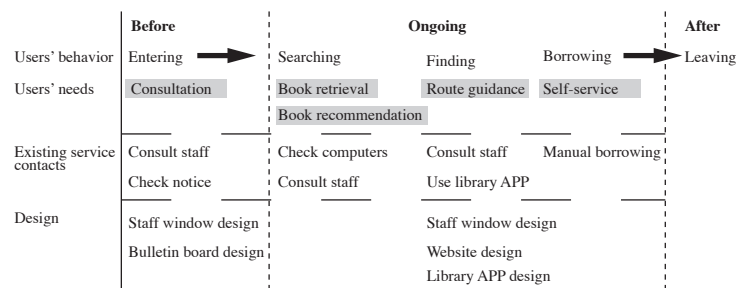
**Table 6:** Weight and ranking of users' needs

### 4.4 Service Touchpoints Analysis

In this process, the whole service is divided into three parts: before, ongoing, and after, which constructs the horizontal axis. The user's behavior, user's needs, existing service contacts, and design schemes are shown in vertical arrangements, as in Figure 5. As a result, the key touchpoints in library borrowing services are demonstrated, providing systematic guidance for practical design. Figure 5 depicts several key touchpoints in the current service process and focuses on improving library services by using existing technologies. Then, Figure 6 reveals the potential touchpoints and proposes more design schemes based on advanced technologies, which are an extension of current services. The touchpoints analysis can help different stakeholders to understand the optimized directions and provide related references for further designs.



**Figure 5:** Existing Touchpoints Analysis



**Figure 6:** Potential Touchpoints Analysis

## 5. DISCUSSION

The five most influential users' needs regarding library service quality are identified, including book retrieval, consultation, book recommendation, self-service, and route guidance. These needs are conducive to improve users' satisfaction. Notably, as they belong to different Kano attributes, designers should consider specific design strategies for practical applications.

The most important and second most important needs, namely book retrieval and consultation, are "Must-be" attributes. The main reason is that they play a fundamental role in affecting users' satisfaction. The research findings can echo the results of the previous study, which implied that *"book resources are expected to be informative and easy to navigate"* and *"Library staff should be approachable and answer inquiries accurately, immediately and clearly"* (Dahan et al., 2016). Similarly, Mutisya & Onyancha's (2020) research also stated that the service quality of libraries lies in workers' performance concerning answering inquiries, serving users promptly, and solving users' troubles. Dahan et al. (2016) emphasized that offering advisory services is essential and necessary. In the Kano Model, "Must-be" attributes are indispensable, and the lack of them will decrease users' satisfaction dramatically. Therefore, libraries should enable users to access the function of book retrieval and consultation more stably and lower the risk of service quality disfunction. For instance, various accessible approaches can be employed to achieve book retrieval function, such as mobile library applications, websites, and intelligent terminals, which are more stable than a single accessible approach. Moreover, designers can use bright colors and large icons to emphasize the retrieval service, to make users find it quickly. Service robots can substitute several library staff, avoiding the fact that users cannot access the function of artificial consultation sometimes.

Two "One-dimensional attributes," namely, book recommendation and self-service, should be fulfilled as soon as possible, since they have a linear correlation with users' satisfaction. "Book recommendation" implies that users should access some personalized and customized services, which appears to coincide with an earlier finding by Yi et al. (2018). Also, the self-service, mainly related to some library facilities, such as borrowing, printing, photocopying, and Internet access, is worthy of note, as Mutisya & Onyancha (2020) suggested. Regarding book recommendations and self-service, libraries should enable users to access them more easily and conveniently. For example, libraries can recommend book resources to readers, according

to their historical borrowing records. This function has high feasibility as big data technologies are available and mature nowadays. In this regard, it can increase the utilization rates of library resources and serve users more efficiently. On the other hand, designers should consider how to simplify the operation process of self-service facilities and pay attention to the related ergonomic factors. Moreover, immediate service feedback is required. Users often like to gain some feedback if they complete one step of the service process, such as *"what parts have been completed," "what needs would be done next,"* and *"how to do it."* It is because immediate feedback can enable users to understand and reduce confusion about the service process.

The "Attractive attributes" are critical aspects of differentiating from competitors. The absence of "Attractive attributes" will not upset users. However, fulfilling them can strongly boost users' satisfaction (Chen et al., 2018). Hence, researchers should attempt to enrich users' experiences related to these attributes. In this study, designers can consider novel and innovative ideas to fulfill the route guidance. For instance, they can use the Global Positioning System (GPS) technology to locate a book and identify its position, through which users can be guided to find it quickly, just like smart map navigation systems. Consequently, designers should consider practicality, novelty, creativity and enjoyment when designing for "Attractive attributes."

## 6. CONCLUSION

In the digital era, libraries have experienced rapid changes and transformations, and their service modes and functions are becoming more diverse and intelligent. It is crucial to pay attention to user's needs, perceptions, and satisfaction under such background since they are associated with service quality. This study explores users' needs and design opportunities to improve service quality in academic libraries, constructing a systematic approach that incorporates the Kano Model with the Rough Set Theory. The research implications are depicted as follows:

- a) In terms of theoretical implications, the three research questions were answered. First, this article attempts to find users' perceptions of existing library borrowing services and summarizes twenty types of users' needs. Next, the five most influential users' needs are identified based on the Kano Model and Rough Set Theory. Finally, a service touchpoints analysis was conducted to investigate how to apply the theoretical results to practical design. Besides, the authors



have proved the effectiveness of the Kano and Rough Set Theory integration approach through a case study of borrowing service design in China's academic libraries. These research findings would be helpful in guiding practical design and form design strategies.

- b) In terms of practical implications, the research findings can provide a reference for policymakers, designers, and library researchers, guiding them on improving library service quality based on users' needs and perceptions. In this case, people can have a more in-depth understanding of the preferential factors influencing users' satisfaction in library service areas.

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