IDENTIFYING AND DETERMINING CROWDSOURCING SERVICE STRATEGIES: AN EMPIRICAL STUDY ON A CROWDSOURCING PLATFORM IN CHINA

XU ZHANG, ZHANGLIN PENG*, QIANG ZHANG AND XIAOAN TANG

School of Management
Hefei University of Technology
Hefei, 230009, China

PANOS M. PARDALOS
Department of Industrial and Systems Engineering
University of Florida
Gainesville, 32611, USA

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Abstract. The crowdsourcing platforms, as mediators and service providers, play a critical role in crowdsourcing initiatives. The service quality of a platform has a direct impact on solver satisfaction, and ultimately affects the platform’s continuous operation. Service quality can be measured by service quality attributes (SQAs). Thus, identifying and quantifying SQAs are crucial to enhance solver satisfaction. Besides, choosing pertinent strategies and determining priorities for the SQAs are another core issue. To address these issues, this study proposes a novel decision framework that combines the Fuzzy Analytical Kano (FAK) and the Importance-performance analysis (IPA) models. Firstly, 24 related SQAs are identified from five dimensions of service quality. Secondly, we quantify these SQAs into a polar form representation scheme in accordance with the FAK model. In addition, the pertinent service strategies and priorities of the SQAs are confirmed by using the IPA model and Kano categories. Finally, decision priority rules for corresponding strategies and priorities of SQAs are constructed. An empirical study is presented to demonstrate our proposed decision framework on ZBJ platform, which is one of the most widely used online crowdsourcing platform in China.

1. Introduction. The internet based on cyber-physical world has profoundly transformed how work is done, from allowing geographically dispersed workers to collaborate to enabling task solutions to be globally crowdsourced, consequently bringing a whole new paradigm named crowdsourcing [16, 33]. The term of crowdsourcing was first proposed by Jeff Howe in 2006. He pointed out that crowdsourcing was a new business model in which enterprises could outsource the well-defined work once done by internal employees or external contractors to a large social group without clear boundaries [17, 43]. Crowdsourcing is an emerging pattern of sharing economy based on information service and collective intelligence. Since the crowdsourcing...
emerged, it has become increasingly popular and been widely applied into many fields by business enterprises. For example, such firms as Dell’s IdeaStorm (since 2007) and Starbucks’ MyStarbucksIdea (since 2008) [7] adopted crowdsourcing approach to collect customer ideas from their own crowdsourcing communities. An increasing number of highly regarded firms e.g., Best Buy, Nokia, Salesforce, BBC, CNN, BMW and Adobe also utilized this approach to obtain solutions [20]. In recent years, for parts of firms, the way to post their requirements and needs in terms of tasks on a third-party crowdsourcing platform has been an alternative choice. The third-party crowdsourcing platforms e.g., ZBJ platform, Amazon Mechanical Turk have made impressive developments.

Service is the core of the internet platforms. Based on user requirement analysis, the platforms make great efforts on planning service attributes, and formulating and implementing relative service strategies for users on specific scenarios. Compared with the traditional internet platforms, the crowdsourcing platforms have two distinctive characteristics. Firstly, the crowdsourcing platforms redefine the process of value creation. Users of the crowdsourcing platforms are not just customers purchasing products or services, but act as intelligence contributors participating in value creation process. The crowdsourcing platforms integrate value chain with experts, suppliers, customers and intelligence resources distributed all over the world, to carry out translation, programming, website design, open innovation and any other added-value creation. Secondly, the objects of transaction are digital information products and services. Crowdsourcing services require solvers to provide knowledgeable solutions, such as industrial product design, human-computer interaction interface design, software system architecture design etc. Solutions are generally customized as knowledge-based creative virtual products, the measurement and evaluation of the quality of solutions lack rigorous and objective criteria, which further increase the complexity and uncertainty for the governance of the platforms. Therefore, the platforms need to formulate professional information audit systems, solution protection mechanisms, solution evaluation systems, and real-time information feedback systems. All of these distinctive characteristics have brought new challenges in operation and maintenance on the crowdsourcing platforms. Therefore, the crowdsourcing platforms have always emphasized their efforts on continuously grasping user requirements, persistently strengthening the service strategies, and optimizing the governance mechanisms to enhance the service quality of the platforms and user satisfactions.

The current researches regarding the governance of crowdsourcing platform have focused on the following two areas: user motivation and behavior [29, 61], and the operation mechanism design toward different application scenarios [31]. On the studies of user motivation and behavior, some researchers have pointed out that user behavior is affected by intrinsic motivations (e.g., the love of community [8, 9], altruism [39, 44], enjoyment [42], sense of belonging [12] and reciprocity [53]) and extrinsic motivations (e.g., Monetary reward, skill enhancement, work autonomy [58], empowerment [14]). In addition, other studies focused on exploring user behaviors in view of equilibrium decision making. For instance, Cheng et al. [11] explored the participant’s equilibrium effort strategy and the optimal decision of sponsor and platform. Sarker et al. [47] introduced a workload allocation policy to seek to balance between worker utilities and platform profit.

On the studies of operation mechanisms, the current literature has mainly focused on crowdsourcing task assignment and recommendation, intellectual property,
crowdsourcing team organization, information security and privacy protection. For example, Yang et al. [56] designed an LBTask model to settle location aware in spatial crowdsourcing tasks. Kurup and Sajeev [27] proposed a task recommendation model based on skill taxonomy and participation probability of existing expert workers. Given the protection of intellectual property rights, the role of crowdsourcing platforms have been discussed [23]. Chen et al. [10] proposed an optimal combination and scheduling method to respond the challenge of allocating heterogeneous solvers to construct a rational crowdsourcing team. Wen and Lin [52] constructed an optimal fees structure of a crowdsourcing platform depending on the game-theoretic model. Veloso et al. [51] used blockchain technology to construct a trust and reputation modelling to solve the problem of false data. à Campo et al. [1] presented that heuristics can be used as a tool for designers of crowdsourcing platforms. Liang et al. [34] confirmed that IT-enabled monitoring system reduces solver preference for high-reputable bidders and reputation premiums. When security and privacy cannot be ensured, users are unwilling to contribute to crowdsourcing initiatives. To address this issue, M.R. Ogiela and L. Ogiela [38] designed Cryptographic algorithms to ensure the appropriate security and information protection.

From the previous literature, one can get a better understanding of solver motivation and the operation mechanism of crowdsourcing platforms as well as the problem of how a certain service scheme takes actions on service quality. However, these works ignore how platforms systematically adjust their service schemes and comprehensively optimize service strategies. Consequently, analyzing which service attributes would influence solver satisfaction, deeply exploring how different service attributes take actions on solver behavior and how to assist the crowdsourcing platforms optimize their existing service strategies are necessary. Combining with the analysis of the distinctive characteristics of crowdsourcing platforms, this study firstly devotes to systematically establish a service quality attributes (SQAs) system for evaluating service quality of the crowdsourcing platforms [55]. Secondly, identifying and quantifying SQAs are discussed as the foundation of assessing service quality of the crowdsourcing platforms. Moreover, confirming particular strategies for each SQA is studied, which is of great significance to the development of these crowdsourcing platforms. In other words, the research objectives of this paper focuses on dealing with the following three issues: Which SQAs will influence solver satisfaction on the crowdsourcing platform? How to quantify these SQAs? What are service strategies and their priorities? To solve these issues, a novel decision framework named FAK-IPA is proposed by integrating Fuzzy Set Theory, Analytical Kano (A-Kano) model and Importance-performance analysis (IPA).

Intergraded Kano with IPA model is applied in many fields to assess service quality. For instance, the integrated Kano-IPA model is utilized to evaluate the service quality of restaurant [40]; Huang [18] combined Kano and IPA models to enhance the service quality of mobile healthcare; Li and Xiao [32] used Kano-IPA model to classify and improve design attributes in mobile tourist guide application. However, it should be noticed that Kano-IPA model is unable to take human uncertainties into consideration and quantify SQAs. Integrated Fuzzy Set Theory, A-Kano model and IPA into a research framework can fix this problem.

The remainder of this paper is structured as follows. Section 2 elaborates the field setting of this research. In section 3, we introduce the notions of Fuzzy Set Theory, Fuzzy Analytical Kano (FAK) Model and IPA. Section 4 qualifies SQAs based on FAK model, gains corresponding strategies for each SQA and presents
the proposed decision framework combining the FAK and IPA models. Section 5 discusses an empirical study that facilitates the understanding of the proposed decision framework on ZBJ platform. Finally, Section 6 summarizes the findings and concludes this study.

2. Field setting: ZBJ platform. Since the ZBJ crowdsourcing platform was founded in 2006, it has grown up into one of the most widely used online crowdsourcing platforms in China. Requesters/Seekers post their needs or tasks on the ZBJ platform and hope to gather collective intelligence from the distributed labor networks [62]; any worker/solver who is interested in the tasks can participate in the crowdsourcing items and submit solutions to these tasks [35]. During the process of crowdsourcing, the platform connects the requesters/seekers with the workers/solvers in a virtual environment on internet, by means of information technology and some service strategies. By the end of 2019, the number of registrations exceeded 19 million, in which contained 13 million solvers with expertise; more than 13 million solvers provided innovative services (e.g., VI design, engineering design, etc.) for more than 7 million Chinese and foreign seekers via ZBJ platform.

To preferably support our research, we first comprehensively investigate management regulations and rules implemented by ZBJ platform e.g., service rules, management standards, tip-off, etc. The regulations and rules play important roles in protecting participant’s rights and regulating their behaviors. Accordingly, they are foundations for guaranteeing the governance effectiveness of platforms. Supported by related documents proposed by ZBJ platform, nine regulations and their associated contents have been identified respectively, as shown in Table 1.

![Figure 1. Services provided by ZBJ.com](image-url)
| Regulation                                      | Content                                                                                                                                 |
|------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------|
| The regulation of service providers on information dissemination or sale | ZBJ platform has the responsibility to maintain the normal operations of the crowdsourcing platform and properly store the information submitted by the solvers...delete the information that defies the relevant rules of ZBJ platform... the information provided by the solvers must be checked by ZBJ platform before posting... |
| The regulation on use of communication tools  | ZBJ platform has the right to examine and supervise information in official communication tools in accordance with laws and regulations. |
| The regulation on handling disputes with ZBJ platform | To maintain order, ZBJ platform will fairly handle disputes among solvers.                                                             |
| The evaluation regulation                      | The trading evaluation entrance will stay open so that seekers and solvers are able to evaluate each other within 30 days after the completion of a transaction. ZBJ platform has the right to shield and delete abnormal trading evaluations. |
| The service regulation of ZBJ Mall             | Solvers are able to use Pig Coins at the ZBJ Mall.                                                                                    |
| The reward distribution regulation             | ZBJ platform has the right to charge 2%-20% of rewards as technical service fees from service providers according to different membership levels... collect 20% of reward as technical service fees from non-member solvers... |
| The handling infringement rule                 | ZBJ platform has the obligation to receive complaints and investigate alleged infringements... ZBJ platform has the right to warnings, rectification within a time limit, deletion of the infringing content, deduction of credit value, and retreat in unilateral infringement... |
| The management regulation of service providers | According to the business circumstance, ZBJ platform will formulate corresponding incentive policies to help solvers sustain development... 30-day turnover conversion rate as a performance indicator. If 30-day turnover conversion rate is higher than the average value, they will be rewarded with Pig Coins. |
| The service agreement                          | ZBJ platform has the obligation to ensure the normal operation of the crowdsourcing platform on the basis of the existing technical level, avoid service interruptions, resume service as soon as possible, and ensure that solvers’ online communication activities run smoothly. ZBJ platform will not sell or lend personal or corporate information to anyone unless the solver has prior permission to do so. |

Source: https://cms.zbj.com/rules-28
Based on above, we further summarize the services provided by ZBJ platform and divide them into three stages upon the process of crowdsourcing tasks. In addition, parts of services are available during the whole process of the crowdsourcing initiatives, as shown in Figure 1.

Before tasks posted, ZBJ platform has already supplied numbers of fundamental services. Firstly, ZBJ designs and builds a fundamental network platform architecture, e.g., constructing crowdsourcing websites and mobile apps, designing a clear solver-interface and layout, continuously maintaining normal operations and repairing website bugs. Secondly, it offers guidelines for task posted (e.g., devising a brief process for task posted) and tools for seeker (e.g., retrieval system, task audit system) and establishes trust mechanism. All of these services aim to guarantee the crowdsourcing tasks can be efficiently and accurately posted on ZBJ platform.

During the process of tasks executed, ZBJ platform constantly updates new services. Firstly, ZBJ platform needs to match task properties with solver capabilities and experiences, and recommends appropriate tasks/solvers to solvers/requesters. Secondly, ZBJ platform needs to propose new incentive strategies in order to motivate solvers to actively participate in the tasks. For instance, it rewards new solvers with 1,000 Pig Coins (a type of virtual currency that can be exchanged for services and commodities at ZBJ mall); registered solvers will be rewarded with Pig Coins once the conversion rate is higher than the average value. Thirdly, ZBJ platform synthetically evaluates each solver by a comprehensive score according to the service skill, service speed, and submission quality. Meanwhile, it offers numbers of tools and trains for solvers to help them to preferably complete and submit higher quality submissions.

Task completed does not mean the end of the services. ZBJ platform provides a diverse range of services including solution audit system, solution protection system, online payment system and intellectual property management. Once the solvers complete the tasks, the solutions will be submitted to ZBJ platform under the help of guidelines. Then ZBJ platform examines each solution by using its audit system. All the solutions will be protected by means of its solution protection system. ZBJ platform has created an online payment service named Fuwubao, as third-party fund trusteeship. After a seeker posts a task, she or he deposits the payment (solver’s reward) with Fuwubao in advance. Meanwhile, ZBJ platform offers the service of enabling solvers to register and own their intellectual property rights, such as trademarks and patents.

In addition, ZBJ platform supplies other important services during the whole crowdsourcing process. For example, it needs to construct personal information system and security mechanism for ensuring the information security of seekers and solvers; ZBJ platform builds an IT-based monitoring system to guarantee the whole transaction. To manage the platform more efficiently across the life cycle, a specialized credit system and reputation system are built by ZBJ platform. To timely and conveniently communicate online, ZBJ platform develops a software tool, which can be interfaced with other professional social applications, such as Wechat, Email, etc. ZBJ platform also has a series of mature mechanism to cope with infringements, complaints and disputes.

As shown in Figure 1, it is of interest to carry out which and how these services influence solver satisfaction. Before we explore previous three issues as outlined above, some related methods should be introduced first.
3. Preliminaries.

3.1. Fuzzy set theory and fuzzy analytical Kano model. Fuzzy set theory was first invented by Professor L.A. Zadeh in 1965 [60]. It takes human subjectivity and vagueness into consideration and presents real-life fuzzy phenomenon or uncertainty by mathematical methodology. On the basis of membership function, fuzzy sets definite the extent of adjective description in human language [30]. Since the development of fuzzy sets, they have been widely integrated into other method [21], and FAK model is the combination of fuzzy approach with A-Kano model.

The Kano model was first developed by Japan’s Professor Noriaki Kano in the 1980s to reveal the asymmetrical, non-linear relationship between customer satisfaction and the performance of quality attribute [24]. According to the importance to overall customer satisfaction, a quality attribute can be classified into one of five categories: Must-be quality, Reverse quality, Indifferent quality, One-dimensional quality and Attractive quality [3]. The explanations of the five categories are shown in Table 2. Quality attributes that belong to different categories affect customer satisfaction in different ways, as shown in Figure 2.

![Figure 2. Kano’s two-dimensional quality model](image)

Kano questionnaire and Kano evaluation table are used as two effective instruments to measure and classify attributes. The Kano questionnaire includes an array of question pairs of functional and dysfunctional forms for each quality attribute to confirm solver satisfaction when a particular service is provided and not provided. By comparing the collected questionnaire with the Kano evaluation table, we are able to identify the category of service attributes.

As the traditional Kano model has been widely utilized in numerous domains, two tiny deficiencies have been revealed. One is that the traditional Kano model is unable to quantify product or service quality. To address this issue, Xu [54] proposed an A-Kano model, which adopted a polar form representation scheme to quantitatively measure solver satisfaction and dissatisfaction. Besides, traditional Kano model failed to take the vagueness and uncertainties of mentality and affection...
Table 2. Explanations of five Kano categories

| Category                                | Explanation                                                                                                                                 |
|-----------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------|
| Must-be quality attribute (M)           | Customers become extremely unsatisfied by the non-fulfillment of this attribute, however, when the attribute is provided or fulfilled, the degree of customer dissatisfaction will be alleviated, but not promoted to satisfaction. |
| One-dimensional quality attribute (O)   | Customer satisfaction has a linear and positive relationship with those attributes. When this quality attribute is absent, customer satisfaction will proportionally decrease. |
| Attractive quality attribute (A)        | Customer satisfaction soars sharply as these attributes increase but the absence of an attribute would be unlikely to lead to customer dissatisfaction. |
| Indifferent quality attribute (I)       | Customer satisfaction would not be influenced by this set of attributes regardless of fulfillment. |
| Reverse quality attribute (R)           | Increasing these attributes would lead to more customer dissatisfaction. |

into consideration. To fix this deficiency, applying fuzzy questionnaires to modify Kano questionnaires provided an effective approach for measuring the vagueness and uncertainties of individuals [30]. Combining fuzzy Kano questionnaires and A-Kano models, FAK model is an appropriate method to quantifying SQAs by considering solver cognitive uncertainties.

3.2. Importance-performance analysis. IPA was proposed by Martilla and James in 1977 to enhance customer satisfaction by focusing on product or service attributes at the very beginning [36]. It has become a promising and powerful mean of guiding companies toward a better understanding of customer satisfaction by identifying the enterprises’ advantages and weaknesses [13]. Typically, by the designation of an attribute’s importance as the y-axis and performance as the x-axis, a two-dimensional matrix can be created and divided into four quadrants according to the means of importance and performance, as shown in Figure 3.

![Figure 3. Importance-performance Analysis](image-url)
Quadrant One: high importance and high performance (Keep Up the Good Work), signifies that both the importance and performance of the attributes are quite high, so the corresponding strategy of the firm should be to remain in its current situation.

Quadrant Two: high importance and low performance (Concentrate Here), means that the attributes are relatively important but exhibit poor performance. A proactive strategy should be adopted with top priority.

Quadrant Three: low importance and low performance (Low Priority), indicates that the attribute is insignificant in conjunction with low performance. The firm should adopt a positive strategy for improving customer satisfaction, but its priority is inferior to Quadrant Two with lower importance.

Quadrant Four: low importance and high performance (Possible Overkill), reveals that those attributes that are suggestive of over performance, so the minor strengths of the firm should be maintained.

Integrated Kano and IPA model have already been successfully applied in many fields. For instance, on the basic of the IPA-Kano model, Kuo et al. [26] categorized the SQAs of mobile value-added services and proposed specific strategies; Huang integrated Kano and IPA models to determine the priority of SQAs in mobile healthcare [18]; Sun and Quan [48] utilized Kano-IPA model to classify and determine the priority of the design features of mobile tourist guide application. However, Kano-IPA model has two limitations: failing to the consideration of human uncertainties and the quantification of SQAs. To fix these deficiencies, this study integrates FKM and IPA models and extends research on FKM-IPA model into the domain of crowdsourcing.

4. The proposed decision framework. Identifying and classifying the SQAs are crucial to increase solver satisfaction by optimizing service strategies of the crowdsourcing platforms. In our study, we propose the FAK-IPA decision framework to identify and quantify the SQAs of crowdsourcing platforms, and then construct a decision rule for confirming the corresponding strategies and priorities of SQAs, as shown in Figure 4. This framework is consisted of three parts, namely identifying SQAs, quantifying SQAs, and determining the strategies and their priorities for SQAs.

4.1. Identification of SQAs. E-S-QUAL and E-RevS-QUAL models are classical tools to measure customer requirements for particular products or services. Since E-S-QUAL and E-RevS-QUAL were proposed, they have been widely applied to evaluate the service quality of internet platforms. As an emerging information service model, the crowdsourcing platforms have the feature of the traditional internet platforms and distinctive characteristics. Therefore, we unify crowdsourcing characteristics into E-S-QUAL and E-RevS-QUAL models. After careful observations and in-depth analysis, 24 related SQAs were identified from five dimensions of service quality: Efficiency, Availability, Fulfillment, Responsiveness, and Privacy.

Efficiency represents the ease and speed of accessing and using a crowdsourcing platform [41]. Internet-based transactions are complex and lead to solver hesitation [41]. Consequently, the speed of overall crowdsourcing process, ease of use and platform layout are fundamental requirements for crowdsourcing solvers. Guarantee those SQAs are able to alleviate solver hesitation. To some extent, real-time information collection and feedback reveal the efficiency of a platform [15]. Diversified usage scenarios will be convenient for solvers and enhance their satisfaction.
Availability refers to the correct technical functioning of a crowdsourcing platform [41], in other words, the system functions are the core of service quality in the dimension of availability. The crowdsourcing platforms have adopted several new system functions, e.g., classification retrieval system, IT-based monitoring system, solver reputation system and recommendation system. Classification retrieval system is one of the manifestations of efficiency for the platforms [45]. IT-Enabled monitoring system, which can be used to record each task, alleviates moral hazard effectively, reduces transaction costs, and intensifies competition [55]. Solver reputation system is essential for evaluating and quantifying the trustworthiness of solvers. Ultimately, ineffective reputation system leads to dissatisfaction and a reduction in productivity [22]. Recommendation system aims to understand solver interests and preferences, and matches suitable crowdsourcing tasks with a specific solver [1]. Therefore, personalized recommendation system would save time for solvers and increase solver satisfaction and loyalty. A good incentive mechanism is able to attract more solvers and arouses willingness to participate in crowdsourcing initiatives [62].
Table 3. Description of SQAs

| Dimension | No. | SQA                                      | Explanation                                                                 | Ref  |
|-----------|-----|------------------------------------------|-----------------------------------------------------------------------------|------|
| Efficiency| 1   | The speed of overall crowdsourcing       | The speed of completing the overall crowdsourcing process.                  | [41] |
|           | 2   | Ease of use                              | The platform is simple to use                                              | [41] |
|           | 3   | Platform layout                          | The layout and architecture of the platform are clear and well organized.  | [41] |
|           | 4   | Information collection and feedback       | The capability of information collection and feedback of crowdsourcing platform. | [15] |
| Availability| 5  | Usage scenarios                          | There are several ways, such as websites, apps, and WeChat Subscriptions, to use crowdsourcing platforms. | [19] |
|           | 6   | Classification retrieval systems         | This system offers a tool for solvers to search for what they need.        | [45] |
|           | 7   | IT-based monitoring systems              | This system supervises false or invalid documents and illegal information, etc. | [55] |
|           | 8   | Solver reputation systems                | This system offers a comprehensive score according to solvers’ service attitudes, service speed scores, etc. | [22] |
|           | 9   | Recommendation systems                   | This system recommends appropriate tasks for solvers and service providers for seekers. | [1]  |
|           | 10  | Incentive mechanism                      | The means by which the platform encourages solvers to participate in crowdsourcing initiatives, such as Pig Coins. | [62] |
| Fulfillment| 11  | Platform’s Image                         | The impressions that solvers have of the platform.                         | [19] |
|           | 12  | Service fulfillment                      | The platform makes accurate promises about their service.                  | [41] |
|           | 13  | Service credibility                      | The platform provides genuine service.                                     | [5]  |
|           | 14  | Real-time service                        | The platform provides real-time services.                                  | [19] |
| Responsiveness| 15 | Finding problems                         | If a problem, such as a website crash or hacker attack, occurs, the platform is able to find it immediately. | [41] |
|           | 16  | The time of recovering platform           | The time taken by the platform to recover normal operations.                | [49] |
|           | 17  | The efficiency of handling complaints     | The time taken to handle complaints and disputes.                          | [59] |
| No. | Feature                                      | Description                                                                 | Reference |
|-----|----------------------------------------------|-----------------------------------------------------------------------------|-----------|
| 18  | The attitude of handling complaints          | The attitude of the platform toward handing complaints and disputes.         | [59]      |
| 19  | Finding new requirements                     | The platform is able to find the requirements of customers in a timely manner. | [49]      |
| 20  | Fulfilling new requirements                  | The platform is able to satisfy the requirements of customers in a timely manner. | [49]      |
|     | **Privacy**                                  |                                                                             |           |
| 21  | The protection of solver information         | The platform protects the information, such as individual and transaction information, of the solvers. | [41]      |
| 22  | The security of payment means                | The payment means of the platform is secure.                                | [45]      |
| 23  | Solutions protection                         | The platform protects solutions and does not let them be used by or leaked to others. | [35]      |
| 24  | Intellectual property protection             | The platform provides clear intellectual property agreements.               | [46]      |
Fulfillment refers to the extent to which a crowdsourcing platform’s promises are fulfilled [41]. A good image not only represents a customer trust in the quality of crowdsourcing service [25], but is also a critical element in solver participation decision. Trust plays a central role in enhancing solver satisfaction in virtual environment [5] and concerns about entrepreneurial survival, competitive success, and trustworthy service strongly influences solver satisfaction. Timeliness of service involving solvers will get service at anytime and anywhere. Therefore, a real-time service is one of the most important advantages [19]. Responsiveness is the effective solving of problems and returning through a crowdsourcing platform [41]. Timely finding out and recovering problems reflect the maintenance and operation performance of a crowdsourcing platform. The paralysis of platform would create great solver dissatisfaction [49]. The efficiency and attitude of handing complaints and disputes are significantly positively related to solver satisfaction [59]. With the rapidly changing of solver requirement, timely finding and fulfilling new requirements is crucial to the continuous operation of a crowdsourcing platform [49].

Privacy contains the protection of solver information and privacy by the platform [41]. In the age of electronic transactions, information and funds are transmitted mostly in a virtual environment, thus information and payment security are prerequisite for solver [45]. Meanwhile, the protection of submitted solutions is also a common concern by solvers. To ease these concerns, some crowdsourcing platforms provide a customized protection mechanism to protect solvers’ solutions [35]. Intellectual property rights are used to create revenue and defend a firm’s competitive position [46].

4.2. Quantification of SQAs. By using FAK model, SQAs can be represented and quantified as a polar form representation scheme. Four quantification steps are as follows.

Step 1: Design the fuzzy Kano questionnaire

Fuzzy Kano questionnaire follows the structure of Kano questionnaire including the functional and dysfunctional form questions for each SQA. With fuzzy Kano questionnaire, respondents enable to express their uncertainties by choosing more than one answer from ‘like’, ‘must-be’, ‘neutral’, ‘live-with’ and ‘dislike’. A set of SQAs is denoted by \( S = (s_i, i = 1, 2, 3, \ldots, n) \), where \( s_i \) represents the \( ith \) SQA. A respondent’s evaluation of each attribute \( s_i \) could be made in the form of functional \( X = (x_1, x_2, x_3, x_4, x_5) \) and dysfunctional \( Y = (y_1, y_2, y_3, y_4, y_5) \) as expressed by Equations (1) and (2).

\[
\begin{align*}
    x_1 + x_2 + x_3 + x_4 + x_5 &= 1 \quad (1) \\
    y_1 + y_2 + y_3 + y_4 + y_5 &= 1 \quad (2)
\end{align*}
\]

Based on the vectors \( X \) and \( Y \), the following fuzzy relation matrix \( R \) associated with each respondent can be obtained as follows:

| (Dys)-functional Question | Like | Must-be | Neutral | Live-with | Dislike |
|--------------------------|------|---------|---------|-----------|---------|
| Functional Question      | \( x_1 \) | \( x_2 \) | \( x_3 \) | \( x_4 \) | \( x_5 \) |
| Dysfunctional Question   | \( y_1 \) | \( y_2 \) | \( y_3 \) | \( y_4 \) | \( y_5 \) |
\[ R = X^T Y = \begin{bmatrix} x_1y_1 & x_1y_2 & x_1y_3 & x_1y_4 & x_1y_5 \\ x_2y_1 & x_2y_2 & x_2y_3 & x_2y_4 & x_2y_5 \\ x_3y_1 & x_3y_2 & x_3y_3 & x_3y_4 & x_3y_5 \\ x_4y_1 & x_4y_2 & x_4y_3 & x_4y_4 & x_4y_5 \\ x_5y_1 & x_5y_2 & x_5y_3 & x_5y_4 & x_5y_5 \end{bmatrix} \] 

(3)

Step 2: Identify the scores of the functional and dysfunctional form questions

Identifying the scores of the functional and dysfunctional form questions need to consider that the intensities of the positive responses are usually stronger than those of the negative responses [7]. Consequently, we adopt DuMouchel’s scoring scheme to alleviate the influence of negative evaluations [54]. DuMouchel’s scoring scheme is shown in Table 5.

| Answers to the Kano question | Functional form of the question | Dysfunctional form of the question |
|------------------------------|--------------------------------|----------------------------------|
| I like it that way           | 1                              | -0.5                             |
| It must be that way          | 0.5                            | -0.25                            |
| I am neutral                 | 0                              | 0                                |
| I can live with it that way  | -0.25                          | 0.5                              |
| I dislike it that way        | -0.5                           | 1                                |

By multiplying DuMouchel’s scoring scheme, the respondent’s fuzzy functional (dysfunctional) form is converted into a single value \( x_{ij}(y_{ij}) \), as shown below:

\[ x_{ij} = x_1 + 0.5x_2 + 0 + (-0.25)x_4 + (-0.5)x_5 \]  

(4)

\[ y_{ij} = (-0.5)y_1 + (-0.25)y_2 + 0 + 0.5y_4 + y_5 \]  

(5)

where \( x_{ij} \) represents the score of the \( j \)th respondent in the \( i \)th SQA for the functional form question, \( y_{ij} \) indicates the score given to the \( i \)th SQA of the \( j \)th respondent for dysfunctional form question. The average scores of both form questions for the \( i \)th SQA are calculated by:

\[ \bar{x}_i = \frac{1}{h} \sum_{j=1}^{h} x_{ij} \]  

(6)

\[ \bar{y}_i = \frac{1}{h} \sum_{j=1}^{h} y_{ij} \]  

(7)

where \( h \) stands for the total number of valid questionnaires.

Step 3: Identify the average degree of solver satisfaction

Table 6. Score for perceived importance

| Not important | Somewhat important | Important | Very important | Extremely important |
|---------------|--------------------|-----------|----------------|---------------------|
| 0.0           | 0.1                | 0.2       | 0.3            | 0.4                 |
| 0.5           | 0.6                | 0.7       | 0.8            | 0.9                 |
To measure the degree of a respondent’s perceived importance of each SQA, we design another part of questionnaire. In this part, we still adopt the scale that proposed by Xu et al. [54], as shown in Table 6. Respondents give the score of perceived importance of each SQA combining subjective cognition with cognitive intensity.

To set the importance score of each SQA, the average degree of solver satisfaction for the functional and dysfunctional form questions can be defined as follows:

\[
\bar{x}_{ie} = \frac{1}{h} \sum_{j=1}^{h} x_{ij}e_{ij}
\]

\[
\bar{y}_{ie} = \frac{1}{h} \sum_{j=1}^{h} y_{ij}e_{ij}
\]

where \(e_{ij}\) indicates the importance score of \(j\)th respondent in \(i\)th SQA.

Step 4: Identify importance index and satisfaction index of the SQAs

For each SQA, the value pair of \((\bar{x}_{ie}, \bar{y}_{ie})\) can be plotted in two-dimensional planes, where the horizontal axis is represented by \(\bar{x}_{ie}\), and the vertical axis is represented by \(\bar{y}_{ie}\). The magnitude of the vector \(|\vec{r}_i|\) represents the overall importance of the \(i\)th SQA, and the angel \(\beta_i\) which between \(\vec{r}_i\) and vertical axis represents the relative level of the \(i\)th SQA’s satisfaction and dissatisfaction [54]. Consequently, the magnitude of the vector \(|\vec{r}_i|\) is named as importance index, while, the angel \(\beta_i\) is named as satisfaction index. They are as follows:

\[
|\vec{r}_i| = \sqrt{\bar{x}_{ie}^2 + \bar{y}_{ie}^2}
\]

\[
\beta_i = \arctan\left(\frac{\bar{x}_{ie}}{\bar{y}_{ie}}\right)
\]

Some conditions should be satisfied:

\[
0 \leq |\vec{r}_i| \leq \sqrt{2}
\]

\[
0 \leq \beta_i \leq \frac{\pi}{2}
\]

Thus, each SQA can be quantified by the above importance index and satisfaction index.

4.3. Determination of the strategies and their priorities for the SQAs. We quantified the SQAs by using the FAK model presented in Section 4.2. The corresponding strategies and their priorities of SQAs can be identified and determined according to the results of the IPA model and the Kano categories.

Step 1: Identify the strategies of the SQAs

According to the location of SQAs in IPA map, the strategies of the SQAs can be identified. IPA map is constructed by depicting the importance index as the x-axis and the satisfaction index as the y-axis. The mean of importance index \(\overline{r}\) and the mean of satisfaction index \(\overline{\beta}\) divide the map into four quadrants, as shown in Figure 5. According to the quadrant in which an SQA is located, its corresponding strategy can be identified.
Figure 5. IPA map for identifying the corresponding strategy of each SQA

Step 2: Identify the Kano categories of the SQAs
As mentioned in Step 1 of Section 4.2, the fuzzy relation matrix \( R \) is confirmed.

Table 7. Kano evaluation table

| Answers of Dysfunctional Questions | Like | Must-be | Neutral | Live-with | Dislike |
|-----------------------------------|------|---------|---------|-----------|---------|
| Answers of Functional Questions   |      |         |         |           |         |
| Like Q                           | A    | A       | A       | O         |         |
| Must-be R                        | I    | I       | I       | M         |         |
| Neutral R                        | I    | I       | I       | M         |         |
| Live-with R                      | I    | I       | I       | M         |         |
| Dislike R                        | R    | R       | R       | Q         |         |

Notes: A, O, M, I and R represent the categories of Attractive, One-dimensional, Must-be, Indifferent, Reverse and Questionable respectively.

By one-to-one matching between the elements in Matrix \( R \) and the cells in the Kano evaluation table (Table 7), the membership degree of the SQAs for each of the respondents is identified as follows:
$t_M = x_2y_5 + x_3y_5 + x_4y_5,$
$t_O = x_1y_5,$
$t_A = x_1y_2 + x_1y_3 + x_1y_4,$
$t_I = x_2y_2 + x_2y_3 + x_2y_4 + x_3y_2 + x_3y_3 + x_3y_4 + x_4y_2 + x_4y_3 + x_4y_4,$
$t_R = x_2y_1 + x_3y_1 + x_4y_1 + x_5y_1 + x_5y_2 + x_5y_3 + x_5y_4,$
$t_Q = x_1y_1 + x_5y_5$  \( (16) \)

where $t_M$, $t_O$, $t_A$, $t_I$ and $t_R$ represent the membership degree of $M$, $O$, $A$, $I$ and $R$ respectively, $t_Q$ represents problematic and illogical answers. The category corresponding to the maximum membership degree is regarded as the result of Kano category for $ith$ SQA of the $jth$ respondent. Finally, the Kano category of $ith$ SQA is determined according to the maximum frequency of the sum of respondents.

Step 3: Determine the priorities of the SQAs in different strategies

Combining the strategy of quadrants with the priority of SQAs’ Kano categories (e.g., $M > O > A$), we further construct the decision priority rule of SQAs. From the perspective of SQAs’ location in IPA map, the SQAs belonging to “Concentrate Here (Quadrant Two)” have the top priority for immediate improvement efforts [36]. And the SQAs located in “Keep Up the Good Work (Quadrant One)” are regarded as major strengths and these SQAs should be maintained and leveraged [28]. In other words, in the strategy set of “Keep”, the SQAs located in Quadrant One are superior to the SQAs in Quadrant Four. Similarly, the SQAs in Quadrant Two are preferred to the SQAs in Quadrant Three in the strategy of “Improve”. In the same quadrant, the priority of SQAs belonging to different categories are different. From the perspective of Kano categories, the priority of the SQAs classified into “Must-be” should be higher than that of “One-dimensional”, which is higher than “Attractive” [7]. Because when a “Must-be” SQA is not provided to the solvers, high dissatisfaction would emerge; when a “One-dimensional” SQA is not offered, lower dissatisfaction would emerge; when a “Attractive” SQA is not offered, solver dissatisfaction would not emerge. By combining the priority of each category with the strategy of each SQA, a decision priority rule can be confirmed, as shown in Table 8.

Table 8. Decision priority rule

| Quadrant | Category | Decision priority rule |
|----------|----------|------------------------|
|          |          | Keep | Improve |
| Quadrant One | Q1-M | 1 | — |
|           | Q1-O | 2 | — |
|           | Q1-A | 3 | — |
| Quadrant Two | Q2-M | — | 1 |
|           | Q2-O | — | 2 |
|           | Q2-A | — | 3 |
| Quadrant Three | Q3-M | — | 4 |
|           | Q3-O | — | 5 |
|           | Q3-A | — | 6 |
| Quadrant Four | Q4-M | 4 | — |
|           | Q4-O | 5 | — |
|           | Q4-A | 6 | — |
5. **Empirical study.** In this section, an empirical study was presented to verify the feasibility of the proposed decision framework on ZBJ platform. Specifically, we designed a questionnaire containing 24 SQA s and posted it as a crowdsourcing task on ZBJ platform. The questionnaire comprised three parts. The first part was a basic personal information investigation. The second part required respondents to rate their satisfaction and dissatisfaction level when a specific SQA was and was not provided by ZBJ platform. The third part needed respondents to rate the importance for each SQA. A total of 218 questionnaires were submitted, and 192 valid questionnaires were used for statistical analysis. According to FAK-IPA model, service strategies (e.g., keep, improve) and its priority for each SQA were identified.

5.1. **Data analysis and test.**

5.1.1. **Descriptive statistics.** In the first part of the questionnaire, respondents were asked to fill in basic personal information including gender, age, completed task type, completed task reward, login website frequency, and total number of completed tasks. 72.5% of the respondents were male aged 31-40 (61.3%), 21-30 (35.6%), less than 20 (2.9%), and more than 41 (0.2%). The majority of respondents on ZBJ platform only participated in one or two types of tasks. It was noted that 89.2% of the respondents were rewarded less than 1,000 CNY. The minimum reward for a submission was 3 CNY. The percentages of individuals who logged into ZBJ 0-3, 3-6, 6-10, and more than 10 times a week were 3.3%, 38.4%, 42.6%, and 15.7%, respectively. Nearly 65% of respondents finished more than five crowdsourcing tasks.

5.1.2. **Reliability and validity analysis.** In order to verify the reliability and validity of the data, it is necessary to perform reliability and validity analysis. The reliability of data refers to the internal consistency and is tested by the Cronbach’s \( \alpha \) coefficient [37]. The Cronbach’s \( \alpha \) coefficient is 0.826, indicating that the data has a considerable reliability. The validity refers to the extent to which a particular item relates to other items. The value of the Kaiser-Meyer-Olkin and Bartlett tests are 0.91 and 3120.195, respectively. Its corresponding companion probability Sig is 0.00, less than 0.05. In principal component analysis, five main factors are extracted from the factor load matrix by the use of the Varimax factor rotation. The cumulative variance contribution rate is 67.02%. Consequently, the data has a considerable reliability and validity for further research.

5.2. **Empirical findings and insights.**

5.2.1. **The findings of IPA.** By implementing Eqs. (1-9), the average satisfaction degree of the functional questions and dysfunctional questions for each SQA were calculated. According to the result of average satisfaction degrees, each SQA was quantified by Eqs. (10-11) into a polar form representation scheme including the importance and the performance indices, as shown in Table 9.

With an average of 0.465 for the importance index and 0.713 for the performance index, an IPA map of ZBJ is drawn, as shown in Figure 6. It shows that ZBJ platform should adopt a proactive strategy to these SQAs which located in Quadrant Two and Quadrant Three; a keep strategy should be adopted to the SQAs which located in Quadrant One and Quadrant Four.

In addition, we can get another two findings from the above IPA map.

1) S21 (Users’ Information Protection), S22 (Security of Payment Means), and S23 (Solutions Protection) are located at the top and affiliated to the dimension of
Table 9. Importance index and performance index for each SQA on ZBJ platform

| SQA  | $x_i$ | $y_i$ | $|r_i|$ | $\beta_i$ | SQA  | $x_i$ | $y_i$ | $|r_i|$ | $\beta_i$ |
|------|-------|-------|--------|---------|------|-------|-------|--------|---------|
| S1   | 0.284 | 0.283 | 0.402  | 0.786   | S13  | 0.362 | 0.462 | 0.587  | 0.664   |
| S2   | 0.333 | 0.383 | 0.508  | 0.714   | S14  | 0.279 | 0.353 | 0.45   | 0.669   |
| S3   | 0.35  | 0.346 | 0.492  | 0.79    | S15  | 0.235 | 0.377 | 0.445  | 0.557   |
| S4   | 0.176 | 0.307 | 0.521  | 0.52    | S16  | 0.251 | 0.351 | 0.431  | 0.621   |
| S5   | 0.31  | 0.289 | 0.424  | 0.819   | S17  | 0.262 | 0.345 | 0.434  | 0.649   |
| S6   | 0.339 | 0.261 | 0.428  | 0.915   | S18  | 0.2885| 0.377 | 0.475  | 0.652   |
| S7   | 0.276 | 0.316 | 0.42   | 0.718   | S19  | 0.347 | 0.334 | 0.482  | 0.804   |
| S8   | 0.259 | 0.229 | 0.346  | 0.845   | S20  | 0.266 | 0.273 | 0.381  | 0.773   |
| S9   | 0.318 | 0.353 | 0.476  | 0.733   | S21  | 0.372 | 0.462 | 0.594  | 0.677   |
| S10  | 0.285 | 0.32  | 0.429  | 0.728   | S22  | 0.436 | 0.497 | 0.661  | 0.72    |
| S11  | 0.308 | 0.3   | 0.43   | 0.797   | S23  | 0.364 | 0.421 | 0.557  | 0.711   |
| S12  | 0.271 | 0.41  | 0.492  | 0.583   | S24  | 0.288 | 0.363 | 0.464  | 0.671   |

Figure 6. IPA map of ZBJ.com

Privacy. It indicates that solvers take more concerns on S21, S22, and S23 than any other SQA and solvers expect that their rights and information could be protected by the crowdsourcing platform.

2) Almost all the SQAs belonging to the dimension of Availability (S5, S6, S7, S8, and S10) are concentrated in Quadrant Four with high performance and low importance. The reason is that ZBJ platform has provided the services exceed solver
expectations on these SQAs, such as the application of information technology, etc. Therefore, these SQAs are no longer in the center of the solver attention.

5.2.2. The findings of Kano classification. The results of the Kano classification of the SQAs were finally identified by calculating the maximum frequency, as shown in Table 10.

Table 10. Kano classification results of SQAs

| SQA | S1 | S2 | S3 | S4 | S5 | S6 | S7 | S8 |
|-----|----|----|----|----|----|----|----|----|
| Kano result | I | M | I | M | I | I | M | I |
| SQA | S9 | S10 | S11 | S12 | S13 | S14 | S15 | S16 |
| Kano result | I | I | M | M | O | I | M | I |
| SQA | S17 | S18 | S19 | S20 | S21 | S22 | S23 | S24 |
| Kano result | A | A | A | A | M | M | M | M |

Notes: $\alpha = 0.1$.

By analyzing the above Kano classification results, the following four findings together with their possible reasons are presented below:

1) There are four SQAs affiliated with the Attractive Quality. S17 (The efficiency of dealing with complaints), S18 (The attitude of dealing with complaints), S19 (Find new requirements) and S20 (Fulfill new requirements) not only reveal the solvers’ requirements, but also represent an emotion appeal that their desire to receive wonderful information service from ZBJ platform.

2) Indifferent Quality includes S1, S3, S5, S6, S8, S9, S10, S13 and S16. Crowdsourcing task deadline is confirmed once the task has been posted, user satisfaction is not affected by S1 (The speed of overall crowdsourcing). User satisfaction is insensitive to S3 (Platform Layout) because with the development of internet technology, most websites have achieved clear layouts. With respect to S6 (Classification Retrieval Systems), S9 (Recommendation Systems), S14 (Real-time service) and S16 (Time to Recover Platform), there are some recommendation algorithms and mature technologies that can be used to meet the users’ requirements, therefore these SQAs are no longer at the center of the users’ attention. Compared to intrinsic incentives, extrinsic incentives (S8 and S10) fail to motivate the solvers to participate in crowdsourcing initiatives.

3) Almost half of SQAs belong to Must-be Quality, e.g., S2, S4, S7, S11, S12, S15, S21, S22, S23 and S24. These SQAs are crucial for ensuring the user satisfaction of ZBJ platform, when lacking these SQAs, users will become extremely unsatisfied. Take S2 (Ease of use) for example, if the crowdsourcing platform is hard to use, solver undoubtedly choose other crowdsourcing platforms with more friendly user interface.

4) Only S13 (Service credibility) is classified into One-dimension Quality. That is, with the performance of S13 improves, solver satisfaction will take the relative liner increase.

5.2.3. The findings of comprehensive strategies and priorities. Combining IPA model and Kano categories, we make a consensus decision with the priority of service strategy for each SQA, as shown in Table 11.

From Table 11, in the service strategy set of “Improve”, the priorities of S12, S21 and S23 are located in the first grade; the priorities of S13, S18 and S17 are
### Table 11. Comprehensive strategies and priorities of SQAs

| SQA   | Category | Priority | SQA   | Category | Priority |
|-------|----------|----------|-------|----------|----------|
|       |          | Keep     |       |          | Keep     |
| S1    | Q4-I     | ——       | S13   | Q2-O     | ——       |
| S2    | Q1-M     | 1        | S14   | Q3-I     | ——       |
| S3    | Q1-I     | ——       | S15   | Q3-M     | ——       |
| S4    | Q3-M     | ——       | S16   | Q3-I     | ——       |
| S5    | Q4-I     | ——       | S17   | Q3-A     | ——       |
| S6    | Q4-I     | ——       | S18   | Q2-A     | ——       |
| S7    | Q4-M     | 4        | S19   | Q1-A     | 3        |
| S8    | Q4-I     | ——       | S20   | Q4-A     | 6        |
| S9    | Q1-I     | ——       | S21   | Q2-M     | ——       |
| S10   | Q4-I     | ——       | S22   | Q1-M     | 1        |
| S11   | Q4-M     | 4        | S23   | Q2-M     | ——       |
| S12   | Q2-M     | 1        | S24   | Q3-M     | ——       |

Notes: Q1 is Quadrant One for short.

respectively located in the second, the third and sixth grades; the priorities of S4, S15 and S24 are located in the fourth grade. It is noticed that maintaining the current service quality typically requires considerable resources investments. Therefore, the priority order of Keep strategy should be identified. In the service strategy set of “Keep”, the priorities of S2 and S22 are located in the first grade; the priorities of S19 and S20 are located in the third and sixth grades. The priorities of S7 and S11 are located in the fourth grade. Almost all SQAs (S21, S22 and S23) belonging to the dimension of Privacy are at the leading position of the priority in both the strategies Improve and Keep. In other words, these SQAs related to Privacy are the most concerned by solvers. There is no corresponding strategy for most of SQAs belonging to the dimensions of Efficiency and Availability. That is, basic platform operations and universal functional systems are no longer in the center of solvers’ attention.

5.3. **Discussion.** This empirical study of ZBJ platform reveals the following research findings: (1) The protection of personal information and submission are the most important SQAs; (2) Focusing more attention on the user experience may lead to higher user satisfaction; (3) Extrinsic incentives fail to motivate the users to participate in crowdsourcing initiatives; (4) The basic fundamental system is no longer joined into the center of the user attention.

On the research of operation mechanism of crowdsourcing platforms, we can get some related findings from other researches. For instance, from the perspective of security and privacy, Yang et al. [57] held that security and privacy are more important and challenging issues in the content of mobile crowdsourcing. Alharthi et al. [2] considered that ensuring location privacy was a substantial attribute to guarantee the engagement and contribution of crowd workers in spatial crowdsourcing. From the perspective of extrinsic incentive, researchers do not reach a consensus on this issue. Some found that extrinsic incentive (e.g., monetary reward) significantly attracted more user participation in different crowdsourcing scenarios, e.g., iStockphoto [8], Taskcn [50], and TopCoder [4].

Based on above, privacy as an importance substantial attribute is similarly confirmed by literature [57] and [2]. Whereas it is worth noting that some empirical
findings of this paper have differences with those of others. From the perspective of privacy, the empirical finding focuses more on what SQAs in the dimension of privacy are the most importance for a platform to optimize governance mechanism. Previous studies focus on the issue of how to protect the solvers’ privacy. In the view of extrinsic incentive, the empirical finding does not reach a consensus with previous study conclusion that extrinsic incentive (e.g., monetary reward) significantly attracted more user participation. The reason may be that crowdsourcing scenarios have effect on empirical findings.

6. Conclusion. To effectively help the crowdsourcing platforms to continuously grasp user requirements, persistently strengthen their service strategies, optimize their governance mechanisms, a novel FAK-IPA decision framework is proposed. Within this framework, firstly, we construct the system of SQAs from five dimensions. Secondly, we quantify the SQAs into a polar form representation scheme in accordance with the FAK model. Thirdly, the service strategies and priorities of the SQAs are confirmed according to the decision priority rule. Finally, an empirical study is presented to demonstrate the validity of our proposed decision framework on ZBJ platform.

The main contributions of this paper can be summarized as follows. First, the system of SQAs for evaluating service quality of crowdsourcing platforms have been constructed, which simultaneously considers the distinctive characteristics of the crowdsourcing service, and the common characteristics of the traditional internet services. Second, given human uncertainty and vagueness in the process of judgment, a novel FAK-IPA decision framework is proposed to identify, quantify and classify the SQAs. Third, this paper identifies the managerial strategies of SQAs and further determines their priorities, which give implications for crowdsourcing platforms to enhance solver satisfaction.

There are two limitations which could be offset by further research. On the one hand, our research analysis does not fully take the costs of optimizing service strategies into consideration. Generally, the internal resources of crowdsourcing platforms are limited and the cost of enhancing SQAs differ from each other. In future research, we will consider the cost of SQAs to maximize service quality and optimize service strategy with limited resources. On the other hand, the results are derived from the application of the proposed decision framework to the crowdsourcing platform ZBJ platform. Therefore, demonstrating these findings in other contexts is worth studying.

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E-mail address: xmtt122@163.com
E-mail address: pengzhanglin@hfut.edu.cn
E-mail address: qiang_zhang@hfut.edu.cn
E-mail address: tangxa@mail.hfut.edu.cn
E-mail address: pardalos@ufl.edu