MiniPI: Minimizing Power Imbalance among Stakeholders for Quality Software Product

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Abstract

The role of requirements elicitation is crucial in the software requirement engineering process as the requirement engineer has to extract the accurate requirements from different stakeholders. However, the problem emerges when the requirement team could not prioritize the extracted requirements because the requirement's nature may vary as different categories of stakeholders have their own perspectives. This ultimately produces a power imbalance among stakeholders. Therefore, minimizing the power imbalance of software requirements among different categories of stakeholders is fundamentally important for a quality software product. Although many contributions have been made to this subject in the past, there is still a research gap available for minimizing the power imbalance among stakeholders. In this paper, we present a novel approach for minimizing the effects of power imbalance by age-sampling among different categories of stakeholders into three groups and then by age-mapping the requirements. After gathering questionnaires from stakeholders, the concerned parties determine the attributes of the Kano model through the filled Kano's questionnaires and afterward, the satisfaction index is calculated by taking the values of the relevant age group into account, which eventually minimizes the power imbalance among stakeholders. In order to verify our methodology, we have performed quantitative analysis by calculating index values and applied a verified Kano's satisfaction formula to calculate the overall satisfaction index which improves the quality level of a software product.

Keywords—Power Imbalance, Stakeholders, Software Product, Kano Model

1 Introduction

Software has become the backbone of the IT Industry. The quality of a software product is an attribute upon which the satisfaction of the customer depends. Managerial-level Stakeholders are the higher authorities of an organization who are responsible for cooperating at higher levels. Failure or success of any software product mainly depends on features that are extracted from stakeholders because it contains all the requirements. Many approaches have been developed in past to enhance the quality of the Software Requirements Specification (SRS) concerning different attributes of the product, for instance, the most cited approach to software requirement prioritization is a MoSCoW method [1]. However, different analyses have also been performed to analyze the main cause of failures of SRS. It has been investigated that ambiguousness is the main cause of SRS failure along with the 3C's (Correctness, Conciseness, Consistency), which might be the major factors that can cause the failures [2]. Ambiguity in requirements can cause power imbalance and produce confusion regarding the nature of specific features in any module. Kano Model is the model of economics which classifies requirements into different categories with respect to their attributes [2]. In organizational projects, mostly the managerial level stakeholders often provide requirements to the engineers where the needs provided by them are mostly not accurate. This could be due to unawareness of end users' demands, which may raise many concerns by the end users, once the software is developed. End users are the category of stakeholders that lies at the lower level of the organization, and are responsible to perform all the proceedings of the task to present it

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to the higher authorities for approval. This may not only affect the daily routine work of end users but could also degrade the reputation of the software company. The reason behind this is the power imbalance between different categories of stakeholders, as low-level stakeholders, like end users, are laymen who do not have knowledge about the exact features of the product and do not even understand the problems that come in the processing at a lower level. Since Kano Model has been implemented on tangible products, the implementation of these Models in software products can enhance the quality of software products by evaluating the satisfaction and dissatisfaction index from customers by applying Kano formulas. In our proposed approach we follow a sequence that consists of the following steps.

- Requirements extraction among stakeholders.
- Develop a questionnaire that consists of the nature of requirements as per the Kano model.
- Calculate the satisfaction level of stakeholders based on the Kano satisfaction formula to ensure the overall customer satisfaction level.

Our main contributions in this paper are as follows:

- We present a method for requirement prioritization as the Kano model basically focuses on the nature of requirements.
- We introduce a novel method to reduce the conflict and the power imbalance among stakeholders.
- We propose a way to quantify the quality of the customers by generating an overall satisfaction index.

The rest of the paper is organized as follows: Section 2 explains the background on the topic and gives some detail about the related works. In section 3, we present our proposed methodology followed by the experimental validation in section 4. Section 5 finally concludes the paper.

2 Background and Related Work

Sauerwein et al. in [2] presented a methodology of the Kano model focusing on how to delight your customers. How can one attain the maximum level of customer satisfaction? What are the basic needs of the customer? Which services can be adopted to increase customers' interest in the product? How can one reduce the chance of customer dissatisfaction? All such questions have been answered by the authors in their work where they have explained a customer satisfaction model of economics known as the Kano Model of customer satisfaction. Shahin et al. proposed in to develop typologies associated with the Kano model [3]. Their findings show that the existing types of the Kano model have some flaws. Their proposed model provides some valued references to the researchers. The Kano Formula gives the satisfaction and dissatisfaction indexes of customers. Kano model defines four attributes on which the Satisfaction Index (SI) and Dissatisfaction Index (DI) of customers can be evolved [11]. However, there are still some major concerns, e.g., in the Kano questionnaire we can get customer needs from which we can categorize the customer's attractive elements [12]. Nevertheless, it may be noted how extremely attractive is this to the customer. Also, the customers may never express their opinions on a particular product or requirements that either fulfill their needs or not [13]. Kano's model is a good tool for industries to analyze main quality attributes to make a good decision on the quality of a product, but this model also has some deficiencies. According to the refined Kano model, quality attributes are further divided into more detailed categories by classifying must-be and attractive attributes into three more categories [14]. The topology demonstrated in [14] shows that five qualities attributes are being used in industries and academia, however, it also has some deficiencies because nowadays we have to produce attractive features to attract customers that will also improve the quality of the product. For this, we have to convert the must-be requirement to attractive by passing it through one-dimensional. This would then become more complete and correct than the previous Kano Model. The authors focused on the new type of Kano model in which starting point, sequence, and slope of curves are working together. The research gives more clear differences between customers and available resources. In the recent market industry, customization has become gradually more important, which leads the company to success [15]. It has become necessary for marketers to make fresh and efficient products. Therefore the authors strongly suggested improving the Kano model in the future.

Zhu et al. in [4] discussed the Kano Model of customer satisfaction which classifies product attributes based on how they are perceived by customers and their effect on customers' satisfaction. These orderings are useful for managing design conclusions in such a way that they should specify when it is good enough or when it will be better. A good product meets all basic requirements and includes as many additional features as possible at a reasonable cost. In their work, the authors performed IPA (importance-performance analysis) in which lower importance is likely to play a lesser role and high importance likely plays a critical role in determining customer satisfaction. A questionnaire

has been designed to get the quality classification of the Kano Model where the positive relationship product features rated the level of satisfaction as higher and vice versa. Revising satisfaction and dissatisfaction indexes of the Kano model by re-classifying indifference requirements has been performed by Shahin et al. [5] where the Kano evaluation table was separated into four groups of indifference towards attractive (IA), indifference towards must be (IM), indifference towards reverse (IR) and indifference towards one dimensional (IO) attributes by implementing on a case study of the presidential elections. The authors produced a questionnaire comprising functional and dysfunctional attributes. After getting details from the questionnaire, indifference requirements were moved toward other attributes of the Kano model. Later on, the satisfaction and dissatisfaction indexes of the Kano model are revised according to the proposed methodology [17]. Nirmalya presented a classification of service quality attributes using Kano's model [6]. This is about service quality elements using Kano's two-way quality model in terms of their instrumentality to customer satisfaction. Service quality attributes are classified into three quality elements: Customer satisfaction index in the form of satisfaction increment index and dissatisfaction decrement index is calculated for each of the quality attributes. No attribute can be identified as indifferent quality or reserved quality.

Economic linearization in 1990*s* had major organizational and governing swings in the banking sector of India. These swings in reforms have led to a lot of progress in the banking sector of India. As a result, the banking industry has undergone a major change. Earlier the Indian banking industry was a public sector bank but later on, there was competition between private and public players. Due to this competition, the banks have to give quality to compete in the market. The main objective was to satisfy the existing customers and to give quality features to attract customers. In this fast-growing process, the researchers gave more quality attributes that can give profit to their business. The managers should know the importance of quality elements so that they can easily differentiate which element will get more customer satisfaction. At the same time, it may be possible that some attributes may not be effective to satisfy the customers. It is important for a manager to classify service quality elements to understand their role in customer satisfaction such classification will help the manager to prioritize the quality attributes to get more customer satisfaction. This could be integrated with the Kano model to give more quality service to the banking sector. Such improvements can improve the service quality of the banking system so that the banks will attract more customers. Abdul Hannan et al. presented value-based requirements classification of software products using fuzzy Kano model [7]. The main idea of research is to pinpoint customer satisfaction that was typically realized as a one-way product, the greater will be the customer satisfaction the more product will be successful. Customer satisfaction was determined to classify quality attributes and to take the customer's mindset to explain to stakeholders how can they use the attributes of given resources. The concept of customer satisfaction was linked with the theory to understand quality attributes this can help developers to make attractive quality attributes to enhance customer satisfaction. Maria Grazia Violante and Enrico Vezzetti presented Kano qualitative vs quantitative approaches [8] through framework by giving classification method and the qualitative descriptions of numerous association curves based on the understanding of the Kano model. Jonathan Hartmann and Matthias Lebherz in [9] presented a survey of the Kano Model development over time (1984-2016), which deals with the development of quality attributes of the Kano model that gained the attention of business and market at the end of the twentieth century, and described their work in terms of three phases known as genesis, discovery, and maturity. Dou et al. presented an application of the combined Kano Model and interactive genetic algorithm for product customization [10]. This technique has been used by companies to quickly respond to buyers. The methodology uses the Kano model to identify several ordered requirements and list them according to customers' satisfaction. There is huge competition in the market so users have to remain in the design process to meet the customers' demands. Interactive genetic algorithm (IGA) has the efficiency to solve the optimized problem, i.e., when the range of attributes is wide, this method reduces the complexity in the product design process.

In literature, plenty of work on requirement prioritization techniques has been presented to enhance the quality for achieving higher satisfaction. In addition to that, several methods have been presented on the application of quality models to develop the software product to achieve quality and satisfy their customers. The significance of these approaches is to achieve a quality product, however, the area of power imbalance has not been explored much. We believe that requirements elicitation is not an individual activity, it is a combination of multiple requirements which are elicited from different levels of stakeholders. So far, various approaches have been suggested to extend

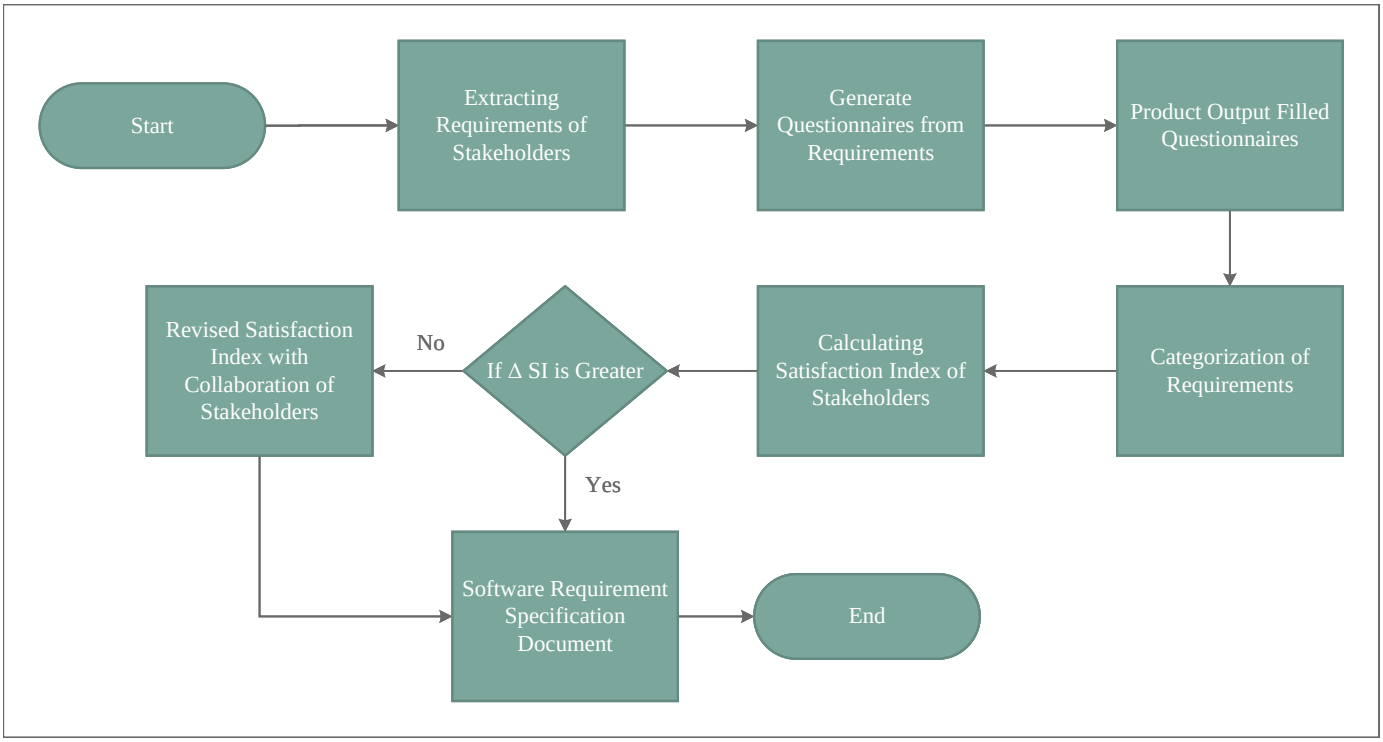

Fig. 1: Complete flow of the proposed methodology. In the first step, requirements are extracted from stakeholders, and based on these requirements, the generation of the questionnaire is processed followed by the requirements categorization based on the Kano model. Next, the satisfaction index is calculated and finally, the satisfaction index value is observed if it is higher the SRS document is finalized otherwise satisfaction index is revised.

the Kano model from qualitative descriptions to quantitative analysis to get customer requirements more precisely and the results of these quantitative methods are mixed with each other. However, our method defines the strengths and weaknesses of qualitative and quantitative Kano approaches and proposes an assessment framework that classifies the relationships between approaches and requirements to select the most appropriate practice for examining the most successful product and service quality attributes affecting customer satisfaction. Kano model allows for identifying the particular attributes that have the potential to elicit Customer Satisfaction or Dissatisfaction.

3 Methodology

In this paper, we focus on qualitative research which aims at the formulation of a quality process that will practically help to develop a quality software product. In the process of obtaining satisfaction indexes for any product, we always use the Kano Model techniques to get the maximum results for any specific product. In terms of any software product, the processing of the traditional Kano model is not so effective because there is a huge difference between the decisions and usage of all users if all the features in the product are usable then the software product will be considered as successful and the satisfaction level of that product will be high. Therefore, we propose a method shown in Figure 1 for getting the maximum result and minimizing the power imbalance among stakeholders. The figure explains the following steps one by one from the start to the end of the process which leads it toward a more appropriate software requirement specification document.

The first step is to extract the requirements from the stakeholders to determine the working principle of the project. We elicit it by using different techniques of elicitation. For some stakeholders, we use the technique of interviews in which we interviewed different stakeholders. In some cases, we use the technique of observation where all stakeholders were discussing their product and we were observing them and eliciting the requirements of the software product. The extraction of requirements can take place using different extraction techniques which then further prioritize their attributes based on a questionnaire.

After getting all the requirements by using eliciting techniques we move ahead in the process of

generating a questionnaire where we produce a two-dimensional questionnaire in which a pair of questions is designed that stakeholders can define in any of the possible ways. The first question shows the concern of stakeholders about the feature of the product and the second question shows what happens if the feature is not included in the software product. By designing two-dimensional questions, we can easily access the requirements of the related software product. We have implemented the presented approach on three different domains of projects in order to analyze the satisfaction of stakeholders.

In the next step, we produce an output-filled questionnaire by surveying three groups ($G1$, $G2$, and $G3$) of basic, intermediate, and managerial levels from which we calculate the results for the filled questionnaire. The designed questionnaire is then given to stakeholders to determine their consent about the requirements of the product.

Further, we do the categorization of requirements based on the output of the filled questionnaire as per the process of the Kano model. The requirements are categorized based on their importance. The requirements must be from the following four attributes, i) *Attractive*, ii) *Must be*, iii) *One-dimensional* and iv) *Indifference*. The stakeholders categorize the requirement based on the above options that ultimately affect the satisfaction index.

After categorization, we calculate the satisfaction indexes and dissatisfaction indexes of all requirements by using the Kano formula. The variables are added after processing the outputs from the filled questionnaire and after that proper SRS document is written. In case of any clash between the decision of stakeholders, the process will follow the next step where we prioritize the requirements by applying different cases to remove the power imbalance between stakeholders.

In this step, we minimize the power imbalance by diving this into three different groups and then categorizing it separately based on all three groups. We apply three cases to get the maximum output result of the ERP system. In the categorization of requirements, we face difficulty in some requirements where clashes between different stakeholders occurred. By applying the following logic based on authority level we get the maximum output of the requirements results. *Case 1*: If $G1$, $G2$, and $G3$ have different opinions from each other then we will follow $G1$'s opinion as they are senior administration of the institute and have more power than $G2$ and $G3$. *Case 2*: If $G1$ and $G2$ have the same opinion and $G3$ has a different opinion then the combined opinion of $G1$ and $G2$ will be followed. *Case 3*: If $G1$ and $G2$ have different opinions from each other then we will follow the opinion of $G3$ because of their higher rank in the institute. Firstly, we take each SI of each feature for $G1$, $G2$ and, $G3$ separately. After getting results we apply these cases to all requirements to get maximum output results for the product and we solved all clashes between stakeholders [16]. After removing all clashes between stakeholders we then revise the feature classification and calculate the SI more accurately. This gives more satisfaction to stakeholders and the product will work more efficiently. After collaboration from stakeholders, we move ahead in the process of making the software requirement specification document.

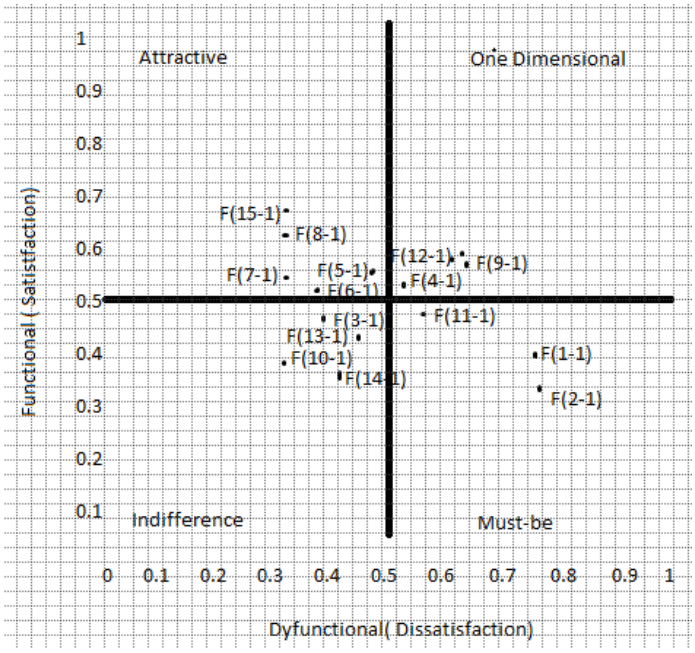

Fig. 2: Influence of features on Satisfaction and Dissatisfaction. The graph depicts the mapping of requirements with respect to the Kano model's attributes

4 Experimental Validation

We have implemented the presented approach on a project developed for the quality enhancement of the University. The questionnaire is specified to the project's nature and was filled by its stakeholders including end users. Following is the analysis of the project: this project is made for the Quality Enhancement Cell (QEC) by the Software Engineering department, University of Azad Jammu and Kashmir (UAJK) located at Muzaffarabad. The main aim of this project is to make quality assurance in the different departments by using a single software where the stakeholders want to manage evaluations of the courses as well as of course instructors. The following

four main features are considered: admin, departmental focal persons, students, and clerks. Quality Enhancement Cell requires that all the evaluations of courses and teachers can be automatically done by the students by using this software. It can also provide the extra features of fee management as well as teachers can upload assignments and quizzes for students. After the feature extraction from interviews and discussions, we made a questionnaire[1] for stakeholders for the better quality of the product. This analysis is based on [17], where we extracted the questionnaires from the stakeholders. After acquiring data from the questionnaire and implementing the Kano model of functional requirements on survey data we obtained the influence of features on Satisfaction and Dissatisfaction which is also shown as a graph in Figure 2. The name of the project is university ERP. Table 1 shows the results that are withdrawn from the ERP after implementing the Kano model. We divided Stakeholders into three age segments as per the reference paper.

Segment	Age	Gender
S1	18-25	M/F
S2	26-45	M/F
S3	45-65	M/F

TABLE 1: Age grouping of the stakeholders

The age groups are divided into three categories. $S1$ ranges from 18 years to 25 years which includes mainly students of the university. The age group $S2$ ranges from 26 to 45 mainly the employees of lower and middle levels. The third age group $S3$ ranges from 45 to 65 and mainly consists of employees from the executive or senior level. The main purpose of dividing the stakeholders on the basis of their age group is that different age groups of stakeholders have their own choices and perspectives among features which mostly causes the power imbalance. The above table shows the detail of the data collected for the ERP software in which we have mapped the 15 requirements by assigning them codes from F $(1-1)$ to F$(15-1)$. After mapping the requirements, we extracted the results from the questionnaires. The results were divided based on the age groups S1, S2, and S3. Other details of these age groups are explained above, satisfaction and dissatisfaction indexes are also calculated based on the relevant age group and then the nature of requirements are determined on the basis of the Kano Model. The histogram analyses for the above results are illustrated in Figure 3. We have also obtained

1. The complete questionnaire can be found here: https://gitlab.com/qaarah/minipi/

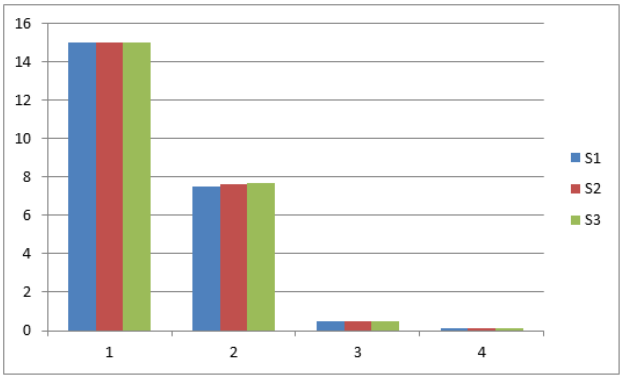

Fig. 3: Histogram analysis of data

the statistical analysis from the above results that are based on the basis of age groups. Table 2 details the summary with respect to age groups.

Segment	Count	Sum	Average	Variance
S1	15	7.5	0.500	0.0225
S2	15	7.63	0.508	0.0172
S3	15	7.66	0.510	0.0227

TABLE 2: Summary with respect to age groups

To measure the significance of our approach we apply a two-factor ANOVA variance procedure on different age groups and obtained the ANOVA table. ANOVA is a test that offers an overall evaluation of a statistical difference between more than two independent means [18]. Table 3 explains the six statistical tests obtained for different components of the ANOVA table which corresponds to the statistically significant difference among groups. We find that the F value in a test is less than the F critical value, thus signification supports the null hypothesis.

5 Conclusion and Future Work

In this paper, we have presented a novel methodology by classifying the stakeholders into different age groups and minimizing the power imbalance among all stakeholders by prioritizing the older age groups. By age-sampling various stakeholder categories into three groups and then age-mapping the requirements, we provide a method for reducing the effects of power imbalance. The parties involved choose the Kano model's characteristics after responding to stakeholder questionnaires. Once the power imbalance has been minimized, we calculate the satisfaction index while taking the value of the appropriate age group into consideration. We conducted quantitative analysis by generating index values in order to validate our methodology. We then used a validated Kano's satisfaction formula

Source of Variation	Sums of Squares (SS)	Degrees of Freedom (df)	Mean Squares (MS)	F	P-Value	F-crit
Between groups	0.000964	2	0.000482	0.023113	0.977164	3.219942
Within groups	0.876267	42	0.020863	-	-	-
Total	0.877231	44	-	-	-	-

TABLE 3: Summary of ANOVA Table

to generate the overall satisfaction index, which raises the bar for software product quality. The significance of this research is later proved by applying the ANOVA technique. Therefore, using our approach, the development of software requirement specification documents can be significantly improved.

In the future, we would like to work on the Cost-effectiveness of this approach which can be calculated by applying the relevant cost model.

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