
A fuzzy Kano-QFD approach for prioritising NBA quality parameters for service quality enhancement: a case of Indian PEIs

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Abstract: The aim of this work is to identify and prioritise the National Board of Accreditation (NBA) of India quality parameters as design characteristics (DCs) to direct and develop educational services by the influence of service quality factors in students' and teachers' perspective in polytechnic education institutes (PEIs) of Madhya Pradesh, India. A framework for identification and prioritisation of the service quality improvement factors for students' and teachers' perspective have been presented in the present study. A fuzzy Kano approach has been used to prioritise service quality attributes into different Kano categories. Then, QFD is used to rank the DCs. It facilitates polytechnic education planners, decision makers, and administrative peoples of institutions to design and develop a strategy to enhance the service quality of PEIs.

Keywords: education; polytechnic education institutes; PEIs; service quality factors; fuzzy Kano; quality function deployment; QFD.

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1 Introduction

The polytechnic education institutes (PEIs) of Madhya Pradesh, India are facing a situation of increased competition. The PEIs has needs to assure the opportunities and threats to ensure competitiveness. The contemporary environment requires focus on enhancement of service qualities and skills of diploma engineers for employment and entrepreneurship. It force PEIs to adopt a strategy 'student as customer' for the employment purpose (Simpson and Siguaw, 2000; Khan and Mahapatra, 2008; Jain et al., 2011). The service quality of PEIs becomes a most significant factor that influence student perception for institutions and appropriate for study (Bayraktaroglu and Atrek, 2010). The teachers' perception is additionally important to enhance the service quality of the institute as one of the main stakeholders of the PEIs. The present study has been focused on a systematic approach to identify and prioritise service quality factors to develop educational services to implement in PEIs of Madhya Pradesh, India based on National Board of Accreditation (NBA) quality parameters as design characteristics (DCs). The service quality factor has been selected from literature related to quality in higher education and with expert's opinion. The suggested service quality factors influence the need of faculty, students and other management peoples regarding the enhancement of service quality of education. The implementation of service quality factors enhance the practices involved in providing appropriate technical skills. The aim of this work is to design and develop a strategy for PEIs using DCs to enhance the service quality. A case study has been conducted on PEIs of Madhya Pradesh, India for the purpose.

Some specific research questions of the study are as follows:

- 1 What should be a strategy for enhancement of service quality in PEIs?
- 2 If realised, what are the DCs for the proposed framework?

2 Literature review

The initiative of this study is to investigate appropriate literature available on the service quality of education, its scope and the approach in measuring service quality. Accordingly literature related to perception of service quality, tools used and applications in the area of education have been reviewed in the coming subsection. The potential approaches of fuzzy Kano and quality function deployment (QFD) have also been reviewed in detail.

2.1 Service quality

The higher education has been gradually accepted as a service industry and as a sector, it must attempt to prioritise the opportunities and needs of its customers, who are students. Parasuraman et al. (1988) reported service quality as the gap between consumers' expectations and perceptions. The study developed a tool called SERVQUAL to review customer perceptions of service quality in service and vending organisations. SERVQUAL has been adopted to assess the quality of diverse service sectors like banking, transportation, hospitals and education. In his study, Jain (1997) has critically analysed the problems of implementation of multipoint entry and credit systems in PEI's of Madhya Pradesh. In his work, need for service quality improvement has been emphasised. Jain (1998a) has proposed an approach for rural development through community polytechnic scheme by supporting and organising the service quality in PEIs. Jain (1998b) has studied the importance of industry-institute relationships and has concluded that effective relation between industry and institute is mandatory for survival of both the entities. He has suggested that quality is the key to achieve it. Jain (1999) has presented the evolvment of information technology to enhance quality and effectiveness of technical education besides the risk of unemployment. Abdullah (2006) has been reported relative effectiveness of three measuring instruments of service quality namely higher education performance, service performance and the moderating scale of these two within a higher education setting with measuring capability in terms of reliability and validity. Sahu et al. (2008) have been examined the effectiveness of assorted factors and develops a mathematical model to measure its effectiveness of technical education. The factors has been divided into seven groups based on administration, infrastructure, teaching effectiveness, students, interaction with industry and society, extracurricular activities, research and development. Pandi et al. (2009) have been presented a model to the top management of higher institutions providing the quality educational service to their customers. In addition to examine quality improvement in the delivery mechanisms applicable to general and broadest area of higher learning in the academic field with critical factors based on top management commitment, system approach to management, customer satisfaction, employee involvement, training, teamwork and continuous improvement. Sayeda et al. (2010) have been explored the adoption of quality management practices in engineering education institutes (EEIs) in India from management's perspective. The service quality has been improved with the adaptation of

factors related to top management, infrastructure, stakeholders and processes. Sahney (2011a, 2011b) has been suggested the quality improvement factors attitude, competence, content, reliability and delivery to evaluate service quality and to measure performance according to customer requirement (CR) through SERVQUAL, Kano, QFD approaches and gap analysis confined to selected management institutes in India. Atakora and Yeboah (2012) have been assessed and examined the quality assurance of polytechnic education in Ghana by specifically looking at the role of stakeholders. Camgoz-Akdag and Zaim (2012) have been presented a conceptual model of service quality based on the application of TQM in education. The study has been used SERVQUAL approach to identify the gap in service quality. Shekhar et al. (2012) have been presented a methodology to determine the overall service quality (OSQ) of PEIs and set the priorities for improvement using fuzzy logic approach. Sudha (2013) has been reported a conceptual total quality management model with service quality factors tangibles, competence, attitude, content, delivery and reliability for the excellence in higher education institutes based on the variable commitment of top management. Gambhir (2014) has presented a model for technical institutions for improvement in quality indicators based on physical resources, faculty and staff, financial resources, governing policies, teaching-learning process, industry-academia interaction and stakeholder's viewpoints. Chui and bin Ahmad (2016) have reported SERVQUAL dimensions tangibles, reliability, responsiveness, assurance and empathy to evaluate the service quality of Malaysian higher education institution with the objective of determining the service variables in the education industry. Ashraf et al. (2016) have acknowledged the service quality factors administrative services, career prospects, cost of education, general facilities, faculty credential, financial aids, library services and curricula structure influences quality education of universities of Bangladesh. Alhalwaki and Hamdan (2019) have reported factors administrative structure and staffing, curriculum, co-curriculum and learning outcomes, faculty policies and practices, student mobility, collaboration partnerships to recommend strategies that facilitate internationalisation in higher education institutions in Bahrain. The service quality factors on student's perception have been prioritised for PEIs of India by Kinker et al. (2019a, 2019b) have identified and evaluate the critical barriers that affect the service quality of PEIs to help decision-makers to eliminate such barriers to improve the service quality of institutes. Kinker et al. (2020b) have proposed a framework to enhance the service quality of (PEIs) enabling the policy makers to address the problems of low enrolment rate and unemployment of the students.

2.2 Fuzzy Kano approach

Kano model has been developed to incorporate customer requisite during the product development phase. The initiative of the Kano model is based on the information that dissimilar types of customer prospect have dissimilar effects on customer satisfaction. Tontini (2007) has presented a method for integration of the Kano model in the QFD to receive essential considerations in the product development process. Sireli et al. (2007) have proposed an integrated Kano-QFD model in the perspective of simultaneous multiple product design. Lee and Huang (2009) have developed a mathematical calculation based on the quality classification of Kano's two-dimensional fuzzy modes and studied service quality of amusement park. Sharif Ullah and Tamaki (2011) have

developed an approach to measure the information of customers' answers to identify product attributes using Kano model. Chaudha et al. (2011) have proposed a methodology for integration of Kano model into QFD. The study decides the most imperative product development activities to achieve utmost customer satisfaction. Avikal et al. (2014) have used a Kano model, fuzzy analytical hierarchy process (AHP) and M-TOPSIS-based collective technique to find the most favourable order of component removal for disassembly line applications. Liao et al. (2015) have presented a Kano model for demands and have proposed models to obtained new products designs. Suwawi et al. (2015) have identified the characteristics of academic website quality of Telkom University using Kano approach. Tsai and Yeh (2016) have proposed a Kano model to identify the attribute affecting innovative services of the e-book. Rinanto et al. (2019) have presented an approach based on the SERVQUAL and Kano to measure the service quality of vocational higher education institutes.

The fuzzy theory has been developed by Zadeh (1965) to develop the established set theory. The vague ideas can be captured from the system with the use of fuzzy set theory. In many studies, the questionnaire and evaluation of CRs in Kano model have been modified using fuzzy theory. Lee et al. (2008) have presented a fuzzy Kano model integrated approach to evaluate CR weights for the product lifecycle management PLM system. Wu and Wang (2012) have proposed a continuous fuzzy Kano model for classifying and evaluating CRs. Vinodh et al. (2013) have presented a fuzzy Kano model for assessment of the sustainability of an automotive organisation. Chyu and Fang (2014) have used a fuzzy Kano method with fuzzy DEMATEL to filter criteria and establish interactions between the criteria. Wang and Wang (2014) have developed a hybrid framework combining fuzzy analytical hierarchy process (FAHP), fuzzy Kano model with zero-one integer programming (ZOIP) to address issues associated with a new product development. Bu and Park (2016) have developed a fuzzy Kano model to improve the precision for collective consumers.

2.3 *QFD approaches*

The QFD has been developed and used as a tool that helps service providers to identify DCs to meet CRs. Sahney et al. (2006) have used QFD approach to assess the quality perspectives of educational institutes. Thakkar et al. (2006) have prioritised student's expectations by using correlation, statistical analysis and QFD approach. Raharjo et al. (2007) have prioritised the needs of faculty and students using the AHP and house of quality. Kelesbayev et al. (2016) have presented an approach to recognise a university policy in terms of service quality enhancement for students. Al-Bashir (2016) has proposed the applicability of QFD in higher education institutes. Bakhru (2018) has prioritised the DCs to fulfill the requirements of students and other external customers using QFD and a path analysis. Karanjekar et al. (2019) have presented a QFD approach for the assessment of stakeholder requirements of technical education institutes. Hamzah et al. (2019) have identified the service qualities in students' perspective and proposed an integrated SERVQUAL-QFD approach to identify their needs. Singh and Rawani (2019) have prioritised the Indian NBA quality parameters to evaluate the quality requirements of students using QFD analysis. Raissi (2019) has identified suitable indicators using QFD for measuring professional skills to meet the employer requirements.

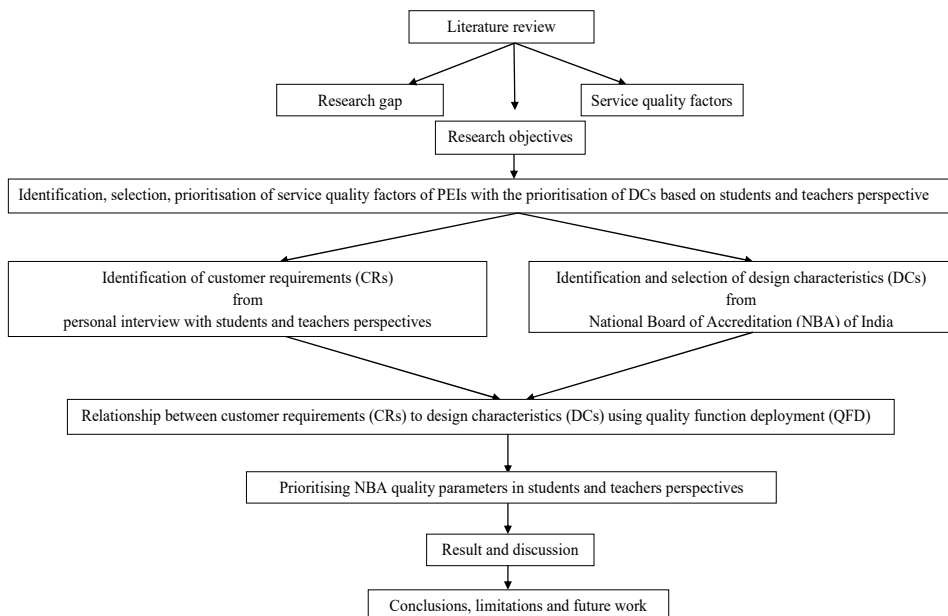
2.4 Research gap

It has been summarised that the majority of the studies related service quality are limited to engineering, management, vocational and higher education institutes. It has also been noticed that the tools like fuzzy Kano and QFD has successfully implemented in different areas for assessment of need of customers and its prioritisation. However, the literature related to service quality of PEIs is limited. Further, an integration of fuzzy Kano model and QFD offer a viable methodology for prioritisation of service quality enhancement of PEIs. Therefore, the viability of proposed work has been established.

3 Research methodology

The proposed methodology has included identification, selection and prioritisation of service quality factors of PEIs with the prioritisation of DCs based on students and teachers perspectives. Six PEIs have been selected for the research set. The fuzzy Kano approach is used to group these service quality factors into different Kano categories. Indian NBA quality parameters as DCs has been prioritised for selected service quality factors CRs using the QFD approach. The research methodology flowchart is shown in Figure 1.

Figure 1 Research methodology flowchart

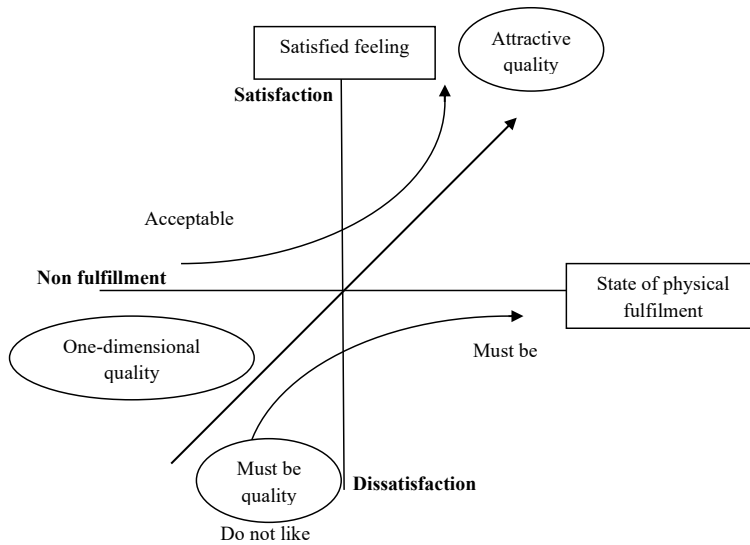


3.1 Objectives

The objectives of the study are:

- To identify the service quality factors of PEIs to increase the enrolment of students against sanctioned intake capacity.
- To identify the service quality factors of PEIs to enhance the skills and knowledge of students to provide them better employment opportunities.
- To prioritise service quality factors based on fuzzy Kano evaluation approach as per the students and teachers perspectives.
- To prioritise DCs based on the students and teachers perspectives (CRs) using QFD.

Figure 2 The Kano model



3.2 Kano model

The customer is usually not able to accurately specify the desired product attributes in the real buying situation. A method that is capable to identify the core of the CRs is Kano model. Kano introduced the theory of attractive quality. The theory of attractive quality proposes six dimensions of perceived quality (i.e., A – attractive, O – one-dimensional, M – must be, I – indifferent, R – reverse and Q – questionable quality). Nowadays, this theory is receiving attention of researchers and practitioners in strategic thinking, business planning, and product development to provide guidance with respect to innovation, competitiveness and product compliance. Traditionally, the Kano approach has been used to associate customer satisfaction and performance of a product or service. In past, the Kano model has been successfully utilised to identify and avoid customer disappointment by categorising attributes according the ability to fulfil customer satisfaction level shown in Figure 2. The fuzzy Kano approach has been used as an effective tool to analyse the need of the customer in the perspective of product or services. The received responses are in a two-dimensional approach and need to prioritise as one of the six discrete groups. The responses have been evaluated and difficult to prioritise for the customer satisfaction. To find correct responses from the customer, the

fuzzy mode has been used to determine the attributes of the product or services and their effects on the level of customer satisfaction or dissatisfaction. The fuzzy Kano questionnaire (FKQ) has two parts: functional and dysfunctional forms of questions. The term functional forms of questions describe; a question is framed in a positive way and dysfunctional forms describe; a question is framed in a negative way. The customer response in Kano approach has been collected in two ways; first traditional Kano questionnaire (TKQ) and second is the FKQ. In TKQ, the received responses may be like, must be, neutral, live with and dislike. In FKQ, the responses are in percentage of attributes and the sum of the values should be 100%. The FKQ reflects the voice of customer distinctly and accurately as compare to TKQ.

3.2.1 Steps in Kano evaluation

- Step 1 First of all, the needs are determined through personal interviews with decision makers. Then, requirements are determined based on the identified needs. Thereafter, a set of attributes that could fulfil the requirements is determined. A questionnaire is then designed that incorporates the functional and dysfunctional form of question related to these attributes. Sample of a question used in present study is shown in Table 1.
- Step 2 Kano have proposed to evaluate questionnaire and find a result by combination of answers of functional and dysfunctional forms of questions. A modified Kano evaluation table has been shown in Table 2.
- Step 3 After completing the evaluation table, the frequencies of each category is counted and data is transferred to Table 3 showing all the requirements with the frequencies of each element and category with highest frequency is said to be the category of requirement.

Table 1 A Kano questionnaire

If 'academic excellence' is considered as a criteria of service quality of PEIs. How would you feel?	1	Like
	2	Acceptable
	3	No feeling
	4	Must be
	5	Do not like
If 'academic excellence' is not considered as a criteria of service quality of PEIs. How would you feel?	1	Like
	2	Acceptable
	3	No feeling
	4	Must be
	5	Do not like

3.3 Quality function deployment

The concept of QFD has been conceived to product development based on innovation. QFD is a versatile tool for quality planning, product enhancement and decision-making. It offers a structured framework to translate CRs into DCs. The QFD approach has three phases: finding customers, recognising customer desires and emergent plans to meet

these desires (Pitman et al., 1995). The relation among WHATs and HOWs and the influence and relative influence of every aspect can be accessible in a house of quality matrix (Eftekhar et al., 2012).

Table 2 A Kano's evaluation table

<i>Requirements →</i>		<i>Dysfunctional (negative) question</i>				
↓		<i>1. Like</i>	<i>2. Must be</i>	<i>3. Neutral</i>	<i>4. Live with</i>	<i>5. Dislike</i>
Functional (positive) question	1. Like	Q	A	A	A	O
	2. Must be	R	(I)Q	I	I	M
	3. Neutral	R	I	I	I	M
	4. Live with	R	I	I	(I)Q	M
	5. Dislike	R	R	R	R	Q

Note: O: one-dimensional evaluation, A: attractive evaluation, M: must be evaluation, I: indifferent evaluation, R: reverse evaluation and Q: questionable evaluation.

3.4 Identification of CRs

The CRs have been identified through the approach and personal interview with students and teachers of six PEIs of Madhya Pradesh India. Further, a structured interview has been conducted to gather their requirements. The identified 18 parameters have been shown in Table 4.

Table 3 Example of frequency table

<i>Requirements</i>	<i>A</i>	<i>O</i>	<i>M</i>	<i>I</i>	<i>R</i>	<i>Q</i>	<i>Total</i>	<i>Kano category</i>
Criteria 1	48	12	10	25	3	2	100	A
Criteria 2	15	55	15	15	0	0	100	O
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3.5 Identification and selection of DCs

The NBA has been anticipated nine quality parameters to assess the quality for polytechnic education are considered as DCs shown in Table 4 and then prioritised using QFD.

3.6 Establishment relationship between CRs to DCs

The relations between CRs and DCs have been established using QFD approach as opinioned by the experts. The matrix has been prepared between CRs and DCs by assigning the different weights as 0 for no relationship between CRs and DCs, similarly 3 for weak relation, 6 for strong relation and 9 for very strong relation.

Table 4 CRs and DCs

<i>Sl. no.</i>	<i>CR – customer requirements</i>	
1	CR-1	Academic excellence
2	CR-2	Alumni
3	CR-3	Audit
4	CR-4	Curriculum structure
5	CR-5	Evaluation and reward
6	CR-6	Extracurricular activities
7	CR-7	Faculty
8	CR-8	Industry institute linkage
9	CR-9	Infrastructure
10	CR-10	Internal revenue generation
11	CR-11	Library
12	CR-12	Physical amenities
13	CR-13	Placement and career counselling
14	CR-14	Society
15	CR-15	Green campus initiatives
16	CR-16	Feedback mechanisms
17	CR-17	Standard operating procedure (SOP) on documents
18	CR-18	Financial autonomy
<i>Sl. no.</i>	<i>DC – design characteristics</i>	
1	DC-1	Formation of well vision, mission and educational objective of the institute
2	DC-2	Develop an employment-based program curriculum and establish a clear teaching learning process
3	DC-3	Maintain course and program outcomes
4	DC-4	Develop a system to record periodic review of the student teachers performance
5	DC-5	Provide faculty information and assure their contribution
6	DC-6	Provide required facilities and technical support to customers
7	DC-7	Sustain continuous improvement of institute
8	DC-8	Establish a standard customer support system
9	DC-9	Maintain financial resources and institutional support

Source: NBA quality parameters of India

3.7 Calculations

- Step 1 Consider the responses of each functional type question as row vector for, e.g., {0.67, 0.22, 0.1, 0.01, 0}.
- Step 2 Do the same for dysfunctional question for, e.g., {0, 0, 0.04, 0.36, 0.6}.
- Step 3 Transpose any one of the responses (functional or dysfunctional) matrix and multiply with other, a new 5×5 matrix will be formed.

- Step 4 Following the formation of the above-mentioned matrix make a comparison with the fuzzy Kano evaluation.
- Step 5 Subsequent to comparison, need to add the corresponding values and represent in the form of $A = \left\{ \frac{0.198}{M}, \frac{0.264}{A}, \frac{0}{R}, \frac{0.1327}{I}, \frac{0}{Q}, \frac{0.402}{O} \right\}$.
- Step 6 Based on the obtained higher value for a particular attribute will consider the particular question. For example; in this problem, the higher value found in one-dimensional so this criterion considered under one-dimensional attribute.
- Step 7 Repeat above-mentioned steps for each response one by one. If the response is higher than take an average of response that can reduce large calculation.
- Step 8 The relative importance scores for the CRs has been measured on a scale of 1–5 moving from least significant to most significant.
- Step 9 The importance scores has been multiplied by the Kano category multipliers and the corresponding importance scores has been calculated.
- Step 10 The relationship between each of the ‘what’ and ‘how’ has been calculated.
- Step 11 The absolute scores have been obtained each column by multiplying the Kano-QFD score by interrelationship score.
- Step 12 The absolute values has been converted to percentages and obtained the relative rankings of DCs.

4 Case study

4.1 Case description

In order to evaluate the fuzzy Kano approach to enhance the service quality by prioritisation of service quality factors in PEIs, a study has been conducted in six PEIs. The study has been focused to observe the importance of service quality factors in the perspective of students and teachers.

4.2 Identification and selection of service quality factors

The service quality enhancement factors are identified and validated through literature review, personal interview and questionnaires. The service quality enhancement factors ‘academic excellence’, ‘alumni’, ‘audit’, ‘curriculum structure’, ‘evaluation and reward’, ‘extracurricular activities’, ‘faculty’, ‘industry institute linkage’, ‘infrastructure’, ‘internal revenue generation’, ‘library’, ‘physical amenities’, ‘placement and carrier counselling’, ‘society’, ‘green campus initiatives’, ‘feedback mechanism’, ‘standard operating procedure (SOP) on documents’, and ‘financial autonomy’ has been selected based on the requirements of PEIs.

4.3 Prioritisation of service quality improvement factors

A list of service quality enhancement factors has been prepared using literature review and then abridged using experts from academia and industry. Separate questionnaire for students and teachers have been developed based on the selected 18 most suitable service quality factors. A total 222 questionnaire set has been provided to students and 85 set to teachers. The total 204 valid response from students and 82 responses from teachers have been received with a response rate of 91.89% and 96.47%. The reliability of response data has been checked with the help Cronbach alpha test and found value of alpha is 0.842 that is under the specified limit.

4.4 Prioritisation of DCs

The QFD matrix in students' and teachers' perspectives has been prepared with CRs and DCs. The CRs (CR-1 to CR-18) are placed vertically in columns and DCs (DC-1 to DC-9) are placed horizontally in rows. The 18 CRs has been selected through response of questionnaires. A five-point Likert scale has been used to rate the importance of these requirements. The respondents have been asked to rate the level of importance to each of the CRs and further asked to relate each of CR to each DC in terms of no relation, weak relation, strong and very strong relation. The results from Kano model has been integrated in QFD. The absolute score has been obtained by the multiplication of Kano-QFD score with the interrelationship score. Finally, the absolute values has been converted in percentage and obtained the relative rankings.

5 Results and discussion

In the present work, the extent of respondent satisfaction and dissatisfaction has been calculated using the methodology proposed by Berger et al. (1993). The average responses have been taken for a single question and a fuzzy Kano approach has been applied in students' and teachers' perspectives for the prioritisation of an attribute. The service quality factors 'physical amenities', 'curriculum structure', 'evaluation and reward' and 'feedback mechanism' has been identified as attractive attributes in student perspectives as shown in Table 5. These factors are 'attractive' to the stakeholder of the PEIs.

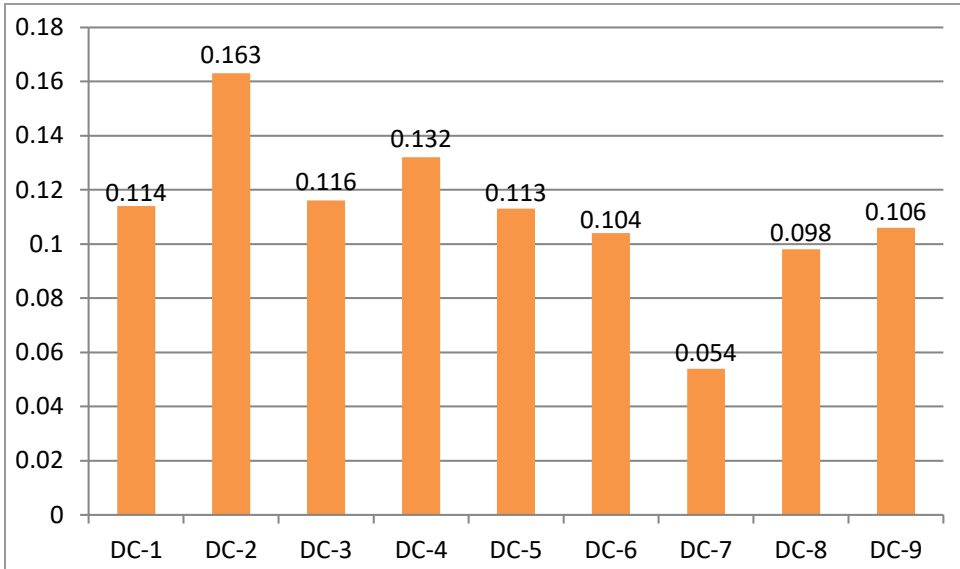
It has been observed that factors 'academic excellence', 'infrastructure', 'library', 'placement and career counselling' and 'faculty' appears into 'must be' attributes. The stakeholders consider these attributes as admission purpose in PEIs. The service quality factors 'industry institute linkage', 'extra-curricular activities', 'alumni', and 'SOP on documents' has been reported as 'one-dimensional' attributes.

The service quality factors 'internal revenue generation', 'faculty', 'SOP on documents' and 'extracurricular activities' has been identified as 'attractive' attributes in the teachers' perception and shown in Table 6. These quality improvement factors attract stakeholders of the PEIs and still, diverse accreditation agency considers these for ranking of PEIs. These factors are important to enhance the quality level of PEIs without any quantification. It has been observed that factors 'curriculum structure', 'academic excellence', 'evaluation and reward', 'infrastructure', 'financial autonomy' and 'library'

are ‘must be’ attributes. The factors ‘physical amenities’, ‘industry institute linkage’, ‘placement and career counselling’, ‘audit’ and ‘society’ have been reported as ‘one-dimensional’ attributes.

A system of service quality for PEIs has been proposed by establishing relation between CRs and DCs. These CRs have been associated with DCs by using a QFD approach. The association has been developed with the help of experts and CRs has been translated into DCs. The ranking of DCs ensure the service quality of PEIs. A QFD analysis has been presented in students’ and teachers’ perspectives useful for planners and managers for the process of implementation of DCs and start implementing to achieve better service quality. The faculty and infrastructure has been identified as ‘must be’ attributes in students’ perspectives and supported by Sahney (2011a, 2011b) that prioritised service quality improvement factors for management education to direct and grow educational services by incorporating CRs through the QFD. The factor faculty has been reported by Vaidya and Khimesara (2018) that prioritised factors to implement the framework in EEIs. The factors ‘curriculum structure’ and ‘evaluation and reward’ have been identified as ‘attractive’ attributes by Sahney (2011a, 2011b) for improving the service quality of education. Further, the ranking of DCs in students’ perspectives has been presented based on the total score calculated for each DC as shown in Table 7 and presented in the form of a histogram chart as shown in Figure 3.

Figure 3 Normalised score of DCs (student’s perspective) (see online version for colours)



The implementation of DCs ensures the service quality of PEIs and analysis has been presented in the students perspectives useful for planners and managers for the process of implementation of DCs to achieve better service quality. Further, the ranking of DCs in teachers’ perspectives has been presented based on the total score calculated for each DC as shown in Table 8 and presented in the form of a histogram chart as shown in Figure 4.

Table 5 Categorisation of factors (students' perspective)

Sl. no.	Service quality factors	Percentage of replies					Total	Category	Customer satisfaction	
		M	O	A	I	R			Extent of satisfaction $A + O / A + O + M + I$	Extent of dissatisfaction $O + M / A + O + M + I$
1	Academic excellence	0.5175	0.2325	0.0775	0.1725	0	1	M	0.31	0.75
2	Alumni	0.21	0.39	0.26	0.14	0	1	O	0.65	0.60
3	Audit	0.2646	0.1554	0.2146	0.3654	0	1	I	0.37	0.42
4	Curriculum structure	0.20335	0.21165	0.29835	0.28665	0	1	A	0.51	0.42
5	Evaluation and reward	0.175175	0.209825	0.329725	0.275275	0.00455	1	A	0.55	0.39
6	Extracurricular activities	0.2793	0.3087	0.2163	0.1957	0	1	O	0.53	0.59
7	Faculty	0.56056	0.20944	0.06256	0.16744	0	1	M	0.27	0.77
8	Industry institute linkage	0.216075	0.428925	0.236075	0.118925	0	1	O	0.67	0.65
9	Infrastructure	0.4648	0.0952	0.0748	0.3652	0	1	M	0.17	0.56
10	Internal revenue generation	0.15745	0.04465	0.12445	0.43885	0.1808	1	I	0.22	0.26
11	Library	0.44835	0.28665	0.10335	0.16165	0	1	M	0.39	0.74
12	Physical amenities	0.1764	0.2436	0.3364	0.2436	0	1	A	0.58	0.42
13	Placement and career counselling	0.4536	0.2664	0.1036	0.1764	0	1	M	0.37	0.72
14	Society	0.20075	0.16425	0.28575	0.34925	0	1	I	0.45	0.37
15	Green campus initiatives	0.3611	0.0989	0.1161	0.4239	0	1	I	0.22	0.46
16	Feedback mechanisms	0.168625	0.186375	0.338625	0.306375	0	1	A	0.53	0.36
17	Standard operating procedure (SOP) on documents	0.266	0.434	0.186	0.114	0	1	O	0.62	0.70
18	Financial autonomy	0.34875	0.10125	0.12375	0.42625	0	1	I	0.23	0.45

Table 6 Categorisation of factors (teachers' perspective)

Sl. no.	Service quality factors	Percentage of replies					Total	Category	Customer satisfaction		
		M	O	A	I	R			Q	Extent of satisfaction $A + O / A + O + M + I$	Extent of dissatisfaction $O + M / A + O + M + I$
1	Academic excellence	0.5037	0.1863	0.0837	0.2263	0	0	1	M	0.27	0.69
2	Alumni	0.2232	0.1368	0.2166	0.3534	0.0434	0.0266	1	I	0.35	0.36
3	Audit	0.1632	0.3468	0.3332	0.1568	0	0	1	O	0.68	0.51
4	Curriculum structure	0.6552	0.1848	0.0352	0.1248	0	0	1	M	0.22	0.84
5	Evaluation and reward	0.587275	0.1112	0.0496	0.26195	0	0	1	M	0.16	0.69
6	Extracurricular activities	0.175775	0.2212	0.3416	0.27145	0	0	1	A	0.56	0.39
7	Faculty	0.129375	0.215625	0.409375	0.245625	0	0	1	A	0.62	0.35
8	Industry institute linkage	0.27675	0.34425	0.15555	0.12505	0.03095	0.05745	1	O	0.50	0.62
9	Infrastructure	0.592	0.148	0.052	0.208	0	0	1	M	0.2	0.74
10	Internal revenue generation	0.1922	0.1178	0.2622	0.4278	0	0		A	0.38	0.31
11	Library	0.4256	0.2144	0.1206	0.2394	0	0	1	M	0.335	0.64
12	Physical amenities	0.343	0.357	0.153	0.147	0	0	1	O	0.51	0.70
13	Placement and career counselling	0.2925	0.3575	0.1925	0.1575	0	0	1	O	0.55	0.65
14	Society	0.187	0.363	0.297	0.153	0	0	1	O	0.66	0.55
15	Green campus initiatives	0.2184	0.2016	0.2784	0.3016	0	0	1	I	0.48	0.42
16	Feedback mechanisms	0.3483	0.0817	0.1083	0.4617	0	0	1	I	0.19	0.43
17	Standard operating procedure (SOP) on documents	0.0714	0.1386	0.5214	0.2686	0	0	1	A	0.66	0.21
18	Financial autonomy	0.4544	0.2556	0.1044	0.1856	0	0	1	M	0.36	0.71

Table 7 QFD (students' perspective)

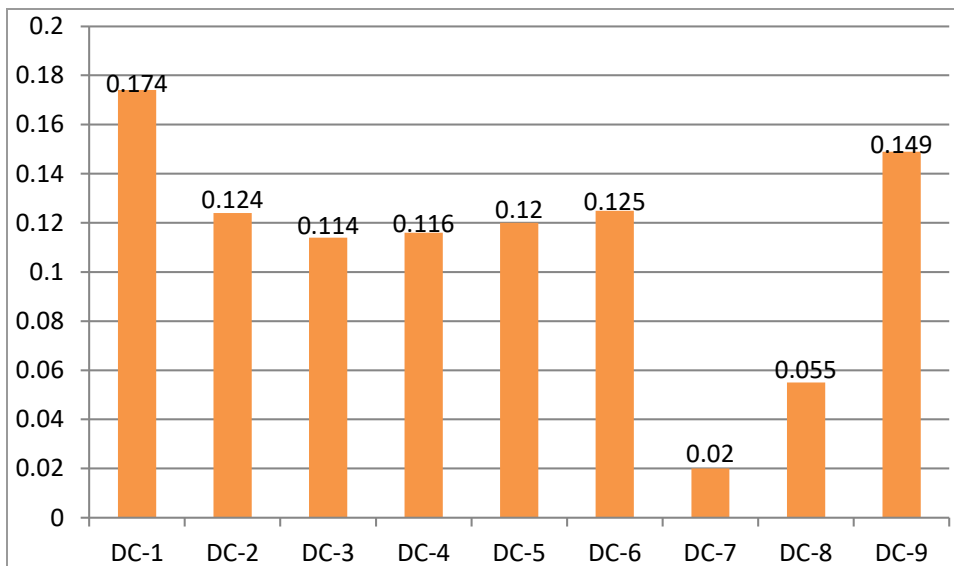
Criteria	Importance score I–5	Kano category	Corresponding importance score	Design characteristics								
				DC-1	DC-2	DC-3	DC-4	DC-5	DC-6	DC-7	DC-8	DC-9
CR-1	4.58	M	4.58	8	6	9	6	8	6	0	6	0
CR-2	3.56	O	7.12	3	4	3	3	6	0	6	0	4
CR-3	0	I	0	0	0	0	0	0	0	0	0	0
CR-4	4.30	A	17.2	9	6	3	0	0	9	3	0	3
CR-5	3.25	A	13	0	6	3	0	0	0	0	9	3
CR-6	3.82	O	7.64	0	3	0	0	0	0	0	0	3
CR-7	4.59	M	4.59	8	6	9	6	0	6	0	8	0
CR-8	4.61	O	9.22	6	9	6	5	8	6	0	3	7
CR-9	4.36	M	4.36	3	7	6	8	9	3	3	0	4
CR-10	0	I	0	0	0	0	0	0	0	0	0	0
CR-11	4.26	M	4.26	7	8	3	8	8	8	3	0	6
CR-12	4.10	A	16.4	0	3	0	6	9	0	3	0	3
CR-13	4.65	M	4.65	9	6	6	7	3	9	3	6	7
CR-14	0	I	0	0	0	0	0	0	0	0	0	0
CR-15	0	I	0	0	0	0	0	0	0	0	0	0
CR-16	3.35	A	13.4	0	0	6	7	0	0	0	5	0
CR-17	2.52	O	5.04	0	9	0	7	0	0	0	6	6
CR-18	0	I	0	0	0	0	0	0	0	0	0	0
Total score				389.59	557.66	396.15	451.47	387.99	354.15	183.33	334.00	361.53
Normalised score				0.114	0.163	0.116	0.132	0.113	0.104	0.054	0.098	0.106
Rank				IV	I	III	II	V	VII	IX	VIII	VI

Note: Kano category A = 4, M = 1 and O = 2.

Table 8 QFD (teachers' perspective)

Criteria	Importance score 1–5	Kano category	Corresponding importance score	Design characteristics								
				DC-1	DC-2	DC-3	DC-4	DC-5	DC-6	DC-7	DC-8	DC-9
CR-1	4.48	M	4.48	8	6	8	8	9	5	0	0	9
CR-2	0	I	0	0	0	0	0	0	0	0	0	0
CR-3	3.56	O	7.12	0	0	0	0	0	9	0	0	0
CR-4	4.20	M	4.20	9	3	3	3	9	0	0	0	7
CR-5	3.82	M	3.82	6	6	8	9	9	3	0	3	6
CR-6	2.82	A	11.28	9	0	7	5	7	3	0	3	3
CR-7	4.52	A	18.08	9	8	9	7	3	0	0	0	8
CR-8	3.85	O	7.7	9	3	0	6	6	8	0	8	6
CR-9	4.21	M	4.21	6	9	0	0	3	9	0	0	9
CR-10	2.28	A	4.56	0	3	0	0	0	6	0	0	0
CR-11	3.85	M	3.85	5	3	0	0	9	3	0	0	6
CR-12	3.20	O	6.40	0	3	0	0	0	9	0	6	3
CR-13	2.52	O	5.04	6	3	0	3	0	4	0	3	0
CR-14	2.25	O	4.50	0	3	3	0	0	0	3	0	3
CR-15	0	I	0	0	0	0	0	0	0	0	0	0
CR-16	0	I	0	0	0	0	0	0	0	0	0	0
CR-17	3.52	A	14.08	4	3	3	4	4	0	3	0	4
CR-18	4.21	M	4.21	3	9	0	0	0	9	3	5	6
Total score				573.80	411.21	376.42	383.42	395.50	413.19	68.37	181.47	492.59
Normalised score				0.174	0.124	0.114	0.116	0.120	0.125	0.020	0.055	0.149
Rank				I	IV	VII	VI	V	III	IX	VIII	II

Note: Kano category A = 4, M = 1 and O = 2.

Figure 4 Normalised score of DCs (teachers' perspective) (see online version for colours)

6 Conclusions, limitations and future work

A framework for identification and prioritisation of the service quality improvement factors for students' and teachers' perspective PEIs has been presented in the present study. Different factors have been prioritised in attributes (must be, attractive and one-dimensional) using fuzzy Kano approach. The findings of fuzzy Kano approach have been integrated into QFD to rank the DCs. It has been observed that students focused on an 'employment-based program curriculum and teaching-learning processes' with a 'system to record periodic review of the student-teachers performance' 'maintaining course and program outcomes' with 'well vision, mission and educational objective of the institute'. It has been observed that teachers focused on 'well vision, mission and educational objective of the institute' with 'financial resources and institutional support' 'facilities and technical support' to develop an 'employment-based program curriculum and establish a clear teaching-learning process'.

The findings of the study are vital for educational planners, academicians, educational practitioners and various stakeholders of PEIs. The adaptation of factors help to enhance the service quality of PEIs and the implementation of factors would lead to the required skills and knowledge as required by the industry and help to reduce the unemployment rate. The limitation has been observed in this study as the inability to assign a weight of each factor that classifies under fuzzy Kano categories. To overcome such issues, researchers are encouraged to use fuzzy MCDM tools with fuzzy Kano approach. The study intended for activities to maintain and support the service quality of PEIs to delight students and to attract for enrolments. The methodology for the applicability of QFD in the education sector would help the PEIs looking for NBA accreditation. In this study, respondents from six PEIs of Madhya Pradesh, India have been considered. In future a

number of additional PEIs in Indian states and other countries may be incorporated as an objective for future research work.

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