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The Model of Requirements Planning of Building Development Based on User Needs

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Abstract. The provision of building facilities for the government is one of the supporting factors for improving the performance of public services. Likewise, state universities are one of the government institutions that play an essential role in increasing the ability and competitiveness of Indonesia. To carry out education, research and community service requires adequate building facilities, one of which is the multipurpose building. This study took the case of planning the construction of the multipurpose building at Diponegoro University. However, the planning process for building construction needs has not been carried out through a structured process and approach considering the proper criteria. Thiscondition causes several buildings to have changed their function from the original plan, which causes waste of costs because renovations must be carried out according to changing needs of the users. This study aims to build a needs planninganalysis model through the Quality Function Deployment (QFD) method approach and the Kano Model to translate user needs into a building specification to align with the user's needs. As a result, the most important criteria for constructing amultipurpose building are the exterior and interior appearance of the facility as well as the planned construction implementation schedule. The essential criteria are construction costs, operating costs and building depreciation costs.

INTRODUCTION

State Universities in Indonesia must organize education, research and community service. In order to increase the nation's competitiveness in the face of globalization in all fields, higher education is needed that is capable of developing science and technology.

According to increasing needs for facilities to accommodate student activities, in 2019, Diponegoro University, as one of the State Universities in Indonesia, plans to build a Multipurpose Building with a total building area of ± 34,500 m^2. *Multipurpose Building* is a building that can be used by the public for various purposes and meets existing criteria in a particular context or is related to the primary function of the building by the capacity of the building [1]. Designing a multipurpose building combines various activities in a flexible building. It takes notice of various things such as the environment as a physical integration and integration with the functions of existing components. The building has a capacity of between 5000-8000 people, is planned to be used for university graduation activities, conventions, exhibitions, indoor sports, robotics competitions, shows/performances, public lectures, wedding events, etc., and also provides supporting facilities such as a student activity centre, retail, restaurant / café, co-working space and banking. Based on its function, the Multipurpose Building is included in the type of convention building. *Conventions* are defined as events of associations or societies that offer educational sessions and exhibitions [1]. Renaghan & Kay [2] identify five characteristics of common meeting room facilities used by meeting planners: the meeting room's size, the complexity of the audiovisual quality, the lighting and the climate control, and the price of the meeting room.

The results of interviews by several related parties showed that the construction of government buildings, including those in universities, was often not carried out through a well-planned planning process based on the criteria for user needs. The main result in building construction is customer satisfaction by expectations. Planning a building that does not meet the needs of the user, it will cause the building to be not functional, or its utilization is not optimal and less supportive of achieving organizational goals.

This study aims to build a planning model based on customer needs. Customer needs will be translated into building specifications based on criteria based on economic, environmental and social dimensions. Quality Function

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Deployment (QFD) is used to find out the building specifications according to user needs in a more structured and systematic manner to achieve the building construction goals.

However, not all building specifications required by users will be suitable for increased customer satisfaction. Therefore, we need an analysis tool that can determine the specifications of the building, which not only meets user expectations but also maximize customer satisfaction. On another side, it is essential to know the minimum building specifications that must be available so as not to cause dissatisfaction from users. This study uses the Kano model to determine the relationship between the user expectations and the level of satisfaction achieved in planning building specifications. Not all facilities are built to face satisfaction, but minimal satisfaction must be achieved, such as a product or service [3].

LITERATURE REVIEW

Multipurpose Building

The Multipurpose Building is a building used by the public for various interests, which meets the criteria in a particular context or is related to the primary function of the building by the capacity of the building [1]. This building is used as a convention and exhibition building. *The convention* is a meeting attended by a group that aims to exchange insights, perceptions, get the latest information, and discuss some plans for the common interest [4]. At the same time, an exhibition is an activity to exhibit or an exhibition held in general [5]. Therefore, the exhibition building can be concluded as a place to hold exhibitions.

Customer Needs

Customer needs can be considered generally based on how easily customers can express their expectations and how quickly they change. Customers' needs are *direct, latent, constant, variable, general, and niche needs* [6]. Immediate needs are needs that customers have no difficulty expressing as something they are worried about when asked about a product. *Latent needs* are needs that cannot be stated directly by customers without investigation. Constants needs are those intrinsic to the task of the product. Varying needs are not always constant; if technological changes can be predicted, these needs will disappear. *General needs* are needs that apply to everyone in the customer population. Niche needs are those that apply only to a smaller market segment of the entire consumer population.

Triple Bottom Line

Sustainability is a measure of how well humans live in harmony with the environment and considers the welfare of society about the needs of future generations and environmental preservation [7]. Elkington [8] extends the concept of sustainability that can be used in the corporate community by developing the triple bottom line principle. Triple bottom line refers to three classifications: social, environmental and financial performance, which are directly related to the concepts and goals of sustainable development, which are interrelated and equally important.

Environment

The environment is defined as the objects, conditions, circumstances, and influences in the room we live in and affect living things, including humans [9]. Otto Soemarwoto in [10] states that sustainable development should be ecologically, socially and economically sustainable. Environmental problems have been generally recognized in the construction industry as necessary [11]. Hill & Bowen [12] proposed a framework for sustainable construction, highlighting environmental issues in specifications and other contract documents. It is related to the implementation of environmental tools such as environmental management systems and environmental impact assessments. Sustainable construction aims to create buildings based on planning by ecological considerations, using natural resources efficiently and environmentally friendly during building operations [13].

Green Building

Green building is one of the efforts made to mitigate the significant impact of building stocks on the environment, society and the economy [14]. Kibert [15] defines a *green building* as a facility or healthy building designed and built using efficient resources and ecological principles. Green architecture or green design is an approach to building construction that can minimize human health and the environment. Efforts are being made to realize environmental sustainability by choosing eco-friendly building materials and environmentally friendly construction practices [15]. The five main elements of green building design are sustainable site design, conservation and water quality; energy and environment; indoor environmental quality; and conservation of materials and resources.

Indoor Environmental Quality (IEQ)

Indoor environmental quality (IEQ) is one of the criteria for assessing the green building rating. IEQ has a significant effect on human comfort, productivity, effectiveness, health, and satisfaction. IEQ consists of several environmental factors: thermal/temperature quality, indoor air quality (IAQ), lighting quality, and acoustic quality [16, 17, 18]. Environmental factors in Indoor environmental quality (IEQ) are thermal quality, acoustic quality, indoor air quality and lighting quality. Thermal comfort has a vital role in occupant productivity. Dissatisfaction in thermal comfort leads to lost productivity [19, 20, 21, 22]. A study shows that changes in temperature in the range 18^{o} C - 30^{o} C can affect the performance of office occupants in tasks such as typing, studying and reading. The temperature range of 21^{o} C - 25^{o} C is a stable temperature range for office productivity. There was a decrease in occupant performance by 2% per 1^{o} C of temperature increase in the temperature range of 25^{o} C - 30^{o} C [23-24]. Acoustic comfort can be achieved by using sound-absorbing materials in the room. The acoustic quality in a room is described by the reverberation time and sound absorption of a room. This is related to the room's surface absorption characteristics and the room's volume [25]. Indoor air quality (IAQ) is the standard of indoor air quality in a building. IAQ has a high impact on office productivity. A workplace with good air quality has higher job performance with office tasks such as typing text, reading proofs, and math assignments [26, 27]. Lighting and daylighting in a building should be strategically designed to achieve a level of light that is comfortable for the human eye. A sound lighting system should use as much of the available sunlight as possible to reduce the energy load of artificial lighting. It is advisable to combine natural lighting factors, glare index and illumination values when developing daylight designs for indoor environments [6].

Economy

According to environmental sustainability, especially essential waste management in the building environment [8], examines the benefits and costs for the community as a whole [28] in terms of the building construction, the economic dimension concerns building construction costs, the available funds, and also the maintenance costs.

The construction cost consists of two main components: direct and indirect costs [29]. Direct costs include all costs associated with the implementation of construction work in the field, including direct costs are material or material costs, labour costs or wages, and equipment costs. Meanwhile, indirect costs include all project costs not directly related to construction in the field, but these costs must exist and cannot be eliminated from the project. Indirect costs include overhead costs, unexpected costs, profits, taxes, and others [30].

The concept of building maintenance is to maintain, restore, and improve each facility according to an agreed standard. The benefit of effective maintenance is to acquire the maximum value for the money invested in the property. Proper and systematic maintenance planning is needed to extend the life of a building, so it becomes an obligation. Effective maintenance can be achieved with the proper maintenance goals, strategies and policies at an early stage. Meanwhile, efficiency in maintenance can be obtained by implementing proactive maintenance [31].

Quality Function Deployment (QFD)

QFD is a method for developing design quality to satisfy customers and translate customer demands into design targets and critical quality assurance points. The product design quality is developed systematically between demand and quality characteristics. It starts with the quality of each component’s function and extends to each part and process [32]. In the process, QFD uses the HOQ (House of Quality) matrix, a nearly universal matrix that can be used to seek priorities for any industrial task [33].

The House of Quality Matrix is a matrix consisting of two main parts; the first is a horizontal section containing information about consumer desires or customer's requirements, and the second is a vertical section called technical responses, which contains responses to customer requirements [34].

The Kano Model

The Kano model is a model that provides an effective tool for categorizing needs and for understanding customer characteristics. The Kano model tries to explain how customer satisfaction will change as the organization meets customer needs. According to Bayraktaroglu & Ozge (2007), there are three main categories in the Kano model, which are, Must-be (basic) needs, One-dimensional needs, Attractive needs, Indifferent, Questionable, and Reverse [35].

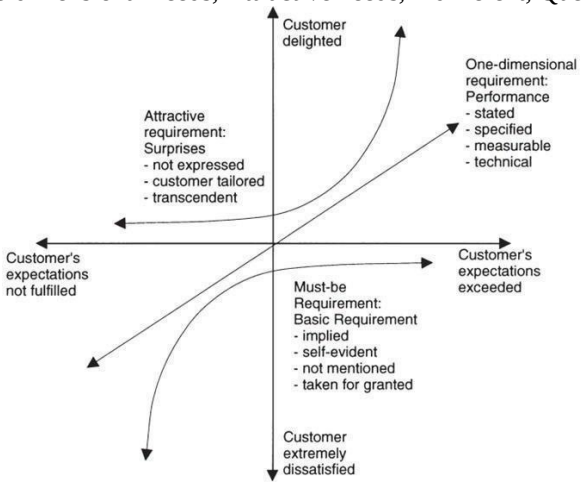

FIGURE 1. Kano Model.

Must-be (Basic) needs are fundamental needs because they are not expressed directly by customers. However, this need must be identified because it is essential to the customer. This need is expected to exist in the product or service. If the product or service does not meet this need, the customer will feel very dissatisfied. This need must be learned from the complaints received from customers. One-dimensional needs are that satisfaction will increase if this need can be met by increasing performance. The increasing performance will result in increased customer satisfaction as well. Attractive needs are if the needs are not met it will cause customer dissatisfaction; this is because customers are not aware of this need. Without those requirements, no one will end up dissatisfied, but if service providers decide to provide them, the customer's level of satisfaction will suddenly increase [3].

Apart from the main categories, there are three other categories: Indifferent, Questionable, and Reverse. Indifferent is that the customer does not care about the presence of this attribute and is not interested in whether this attribute is present. Questionable is a situation that arises when there is a contradiction in the customer's answer to the pair's question. This indicates an error in the expression of a question, a misunderstanding of a question, or an incorrect response. Reverse means that some respondents' satisfaction has decreased with this question, but they also expect the opposite.

RESEARCH METHODS

This research will be conducted in several stages; the first stage determines the variable of customers' voices obtained from several construction-related journals. The next step is to calculate the weight of the interests of each voice of customers by finding the average of each respondent's answer. Then determine the relationship between the voice of customers and the technical response. The relationship value shows how strong the relationship between the technical response and the voice of customers is. The relationship value will be used to find the technical response rating, which shows the priority of the technical response in order to increase user satisfaction.

Determination of this relationship aims to synchronize the technical response with customers' needs in the voice of customers to obtain quality criteria to meet the needs of building users. The Kano model is used to determine user satisfaction regarding the facilities provided at the Diponegoro University Multipurpose Building.

The data collection is conducted by observation, interviews, and delivery of the questionnaires. The observations

are conducted directly on the process of implementing the DED of the Multipurpose Building. The questionnaire used in this study includes two stages, the first stage is the QFD questionnaire, and the second stage is the Kano questionnaire.

The QFD questionnaire is used to determine users' needs and expectations through the quality of the Multipurpose Building facilities. The questionnaire consists of two parts: a questionnaire to get the weight of customers' voice by using a scale of 1 to 9, and a questionnaire to determine the relationship between the voice of customers and the technical responses using a scale of 0,1,3,9. The second stage of the questionnaire is a Kano questionnaire, which is used to observe user satisfaction regarding the facilities provided at the Multipurpose Building.

RESULTS AND DISCUSSION

The success of a project in a micro perspective is viewed from the completion criteria, such as time, cost, quality. Several journals on construction obtain the determination of the variables used in the Quality Function Deployment process. The following is a definition of the criteria used in Quality Function Deployment:

TABLE 1. QFD Criteria.

Dimensions	**Criteria**	***Voice of Customers (VOC)***		**Reference**
Environment	Quality	*VOC1*	*Functionality*	[36]
		VOC2	Flexibility	
		VOC3	*Accessibility*	
Economy		*VOC4*	*Indoor quality*	
		VOC5	*Aesthetics*	[37]
		VOC6	*Safety*	
Social	Cost	*VOC7*	*Total cost of ownership*	[38]
	Time	*VOC8*	*Construction time*	[39]

TABLE 2. Technical Responses QFD.

No.	**Technical Responses**
TR1	Types of rooms inside the Multipurpose Building
TR2	Disability facilities
TR3	Easy access lifts and stairs at every corner
TR4	Adequate security
TR5	Earthquake resistant construction
TR6	Availability of smoke / fire detectors
TR7	Efficient fire extinguishing system
TR8	Parking capacity
TR9	Acoustic comfort, reverb and noise
TR10	Thermal comfort
TR11	Lighting
TR12	The facility's exterior and interior appearance
TR13	Construction costs, operational costs, building depreciation costs
TR14	Timeliness of completion of construction
TR15	Time of construction
TR16	Plan of development implementation schedule
TR17	Development maintenance services

The technical response is to respond to the voice of the customer "functionality" (VOC1), and "flexibility" (VOC2), namely the TR1 "type of room" inside the Multipurpose Building, namely the convention room, which is designated as a graduation venue, large-scale exhibitions, concerts, and weddings, an exhibition room which is designated as a small and large scale exhibition space, and a display area, a meeting room for conferences and seminars, a co-working space/learning space that can be used for working spaces, student activities, cafes and offices, co-living which is designated as a hotel, lobby, and restaurant for guests who are carrying out activities at the Multipurpose Building, flexible space can be used for various functions, namely hall, outdoor space, plaza and parking area, and business centre / retail area. This retail area will be leased to third parties. The "convention", "exhibition", "meeting" room can be partitioned into smaller sections so that it can respond to the voice of customer "flexibility" (VOC2) or adaptability. There are two technical responses in response to the voice of customer "accessibility" (VOC3), namely TR2 "disability facilities" and TR3 "easily accessible lifts and stairs at every corner". There are three technical responsesto respond to the voice of customer "indoor quality" (VOC4), namely TR9 "acoustic comfort, echo, and noise", TR10"thermal comfort", and TR11 "lighting" based on previous studies on building and environment. The technical response to the "aesthetic" (VOC5) voice of the customer was TR12 "facility exterior and interior appearance".

There are four technical responses to respond to the voice of customer "safety/safety and security" (VOC6), namely TR4 "adequate security", TR5 "earthquake-resistant construction", TR6 "availability of smoke/fire detectors", and TR7 "efficient fire extinguishing system". The technical response to respond to the voice of customer "cost" (VOC7) is TR13 "construction costs, operational costs, building depreciation costs". The technical response to the VOC8 "timing" was TR14 "construction completion time", TR15 "construction implementation time", TR16 "construction implementation schedule plan", and TR17 "construction maintenance service".

Technical responses to meet user needs, which are then grouped using the Kano Model. The technical response rating (TRR) value in QFD is obtained by calculating 100 x the amount of ("relationship strength" times "relative weight") for each customer requirement. The technical response rating value shows the priority level of the need attributes according to the user. The higher the technical response rating value, the higher the priority attribute needs according to the user. The value of the technical response rating depends on the number of related questions asked by the researcher; this results in the attribute getting a high TRR value is not necessarily an attractive category in the Kano model.

Attributes with a TRR value above 300 are disability facilities, elevators and stairs that are easily accessible at every corner, the availability of smoke or fire detectors, and lighting. The four attributes in the Kano model fall into the one-dimensional category (O), which means that user satisfaction is proportional to the proportion of the presence or absence of attributes in the building.

The following are the technical responses rating and Kano categories in each technical response:

TABLE 3. Kano Model Categories.

Technical Responses	Code	TRR	Kano
Disability facilities	TR2	350.75	O
Easy access lifts and stairs at every corner	TR3	350.75	O
Availability of smoke / fire detectors	TR6	350.75	O
Lighting	TR11	344.59	O
Type of room inside the building	TR1	256.15	I
Efficient fire extinguishing system	TR7	239.38	O
Earthquake resistant construction	TR5	233.75	O
Development maintenance services	TR17	233.75	O
Acoustic comfort, reverb and noise	TR9	229.29	O
Thermal comfort	TR10	229.29	O
Parking capacity	TR8	228.37	O
The facility's exterior and interior appearance	TR12	146.79	A
Adequate security	TR4	122.38	O
Timeliness of completion of construction	TR14	108.75	I
Time of construction	TR15	108.75	O
Plan of development implementation schedule	TR16	108.75	A
Construction costs, operational costs, building depreciation costs	TR13	104.69	M

Note: Must-be needs (M), One-dimensional needs (O), Attractive needs (A), Indifferent (I), Questionable (Q), and Reverse (R).

Attributes with a TRR value between 200 to 300 are room type, efficient fire extinguishing system, earthquake-

resistant construction, development maintenance services, acoustic comfort, reverb, and noise, thermal comfort, and parking capacity. The type of room in the Multipurpose Building gets a high score of the voice of the customer but gets an indifferent category (I). It means that the user does not care about the presence of this attribute and is not interested in whether this attribute is present. However, the rest of the six attributes are included in the one-dimensional category (O).

Attributes with a TRR value between 100 to 200 are the exterior. Interior appearance of the facility and construction implementation schedule plan is categorized as attractive (A), adequate security and construction execution time are one-dimensional categories (O), construction costs, operational costs, and building depreciation costs are must-be categories (M). Timeliness of completion of construction is an indifferent category (I).

CONCLUSION

There are three criteria for customer needs that have been traced. The first criteria are the quality criteria: functionality, flexibility, accessibility, indoor quality, aesthetic, and safety. The cost criterion is the total cost of ownership and the time criterion is construction time.

The facility's exterior and interior appearance and plan of development implementation schedule are essential criteria to meet users' needs in constructing a multipurpose building. Without those requirements, no users will end up dissatisfied, but if it is decided to provide them, their level of satisfaction will suddenly increase.

The type of room inside the building and timeliness of construction completion is not essential criteria. This is because the building is only used as a means of supporting activities at the university.

Construction costs, operational costs and building depreciation costs are essential criteria needed to build the Multipurpose Building in university. If the building does not meet this need, the users will feel very dissatisfied.

Disability facilities, elevators and stairs that are easily accessible at every corner, availability of smoke or fire detectors, and lighting, efficient fire extinguishing system, earthquake-resistant construction, development maintenance services, acoustic comfort, reverb and noise, thermal comfort, parking capacity, time of construction are essential to increase user satisfaction as well. Because that satisfaction will increase if this need can be met by increasing performance, the level of user satisfaction is proportional to the proportion of the presence or absence of attributes in the building.

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