Behavioural and functional based design of high-rise public housing project in Jakarta, Indonesia

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Abstract. Jakarta, which is the largest metropolitan city in Indonesia, has a population of 10.37 million people and an area of 661.5 km². Jakarta's population density of 15,677 people/km² is still far from the ideal population density of 100 people/km². With a high population density, vertical housing development (high-rise residential buildings) is an essential development goal. Indonesian high-rise public housing is focused on fulfilling technical requirements with a perspective only from the designer or developer. In contrast, in the construction of vertical high-rise public housing, a performance-based design that is focused on the user is needed as one of the main stakeholders. Results from survey and partial least square modelling concur that three elements (behavioural, functional and technical) have a 68.3% influence in determining user satisfaction. Each of the elements contributes a positive influence, with the behavioural element as the highest influencer of 44.5%, followed by the functional element at 38.6% and the technical element, which only has 15.4%. These results can also be interpreted as the overall success of the high-rise public housing project.

1. Introduction

Jakarta is the most populous city in Indonesia and has various problems due to its population of 10.37 million people and area of 661.5 km². Jakarta's population density of 15,677 people/km² is far from the ideal population density of 100 people/km².

One of the problems arising from such a high-density city is housing, especially where the low income community has difficulties in meet their housing needs at an economical and liveable price. This is a particularly prominent issue since the price of land in Jakarta has become increasingly expensive. It should be noted that welfare is still not evenly distributed among the people in Jakarta, with many people living in poverty.

From past studies, it can be seen that the success of a construction project is not only seen in the success of the project management in building the project, but also when the results of the project have been delivered and are used. Therefore, user satisfaction needs to be studied for high-rise public housing projects to determine the overall success of the projects.

Feedback from residents can be used as a guide for future development. Indirectly, it can also improve the design and performance of buildings [1].
2. Literature review

2.1. Project success criteria in construction

Traditional criteria for time, cost and quality have long been used to evaluate the performance and success of a project [2]. These three criteria are the basic criteria for project success and were deemed the "iron triangle" by Atkinson (1999). Although the basic criteria are easy and timely to measure, they have been criticised for being inadequate for several reasons.

Alarcon [3] argue that these basic criteria are not suitable for prolonged improvement or progress because they are not effective in identifying causes of productivity and quality losses. These parameters do not provide an adequate picture of the potential improvement and the information obtained is usually too late to do the corrective action. The success of the project is the concept of strategic management, where project efforts must be aligned with the company's short- and long-term goals.

New measures of success include participant satisfaction [4], satisfaction of interpersonal relationships with members of the project team [5], stakeholder satisfaction [6] and client satisfaction [7]. In the construction industry, the concept of project success remains ambiguous [8, 9]. However, there have been many attempts to explore the concept of success and to develop different frameworks to measure the success of construction projects. Ahadzie [10] introduced criteria for the success of mass housing development projects, which include environmental impacts, customer satisfaction, overall quality and costs, and time. The third dimension is market success, which relates to the potential of the project in contributing to the company's success in the long run in terms of gaining a competitive advantage, increasing company reputation, increasing shares and earning income and profits [11].

Such research indicates that the end-user perspective plays an important role in the success of a project. Therefore, this study investigates which variables have a major influence on the satisfaction of inhabitants in high-rise public housing.

2.2. End-user or residential satisfaction

In this study, the satisfaction of high-rise public housing residents is investigated to determine the critical influencer. Residential satisfaction is defined as the emotional response of the resident, i.e., positive or negative feelings possessed by residents of the dwelling [12, 13]. Residential satisfaction has been used as a measure to test the success of housing development projects.

Designers rarely receive useful feedback regarding the performance of buildings. Therefore, the actual user evaluation of a building is important to improve the quality of the design [14]. Several studies have assessed the level of residential satisfaction. Mohit and Azim [15] conducted an assessment of residential satisfaction in public housing in Hulhumale, Maldives. In Malaysia, Mohit et al. [16] revealed that residents in low-cost housing newly built in Kuala Lumpur were quite satisfied with their housing conditions but most were dissatisfied with the support services of housing units and the social environment of the plantations. Huang and Du [17] conducted a residential satisfaction assessment and examined the determinants based on a survey of residents of public housing in Hangzhou, China.

These studies conclude that it is essential to investigate the satisfaction level of the residents in housing to see the variables that play important parts in the success of the public housing project. It is also showed that different countries have different credentials to what determines the satisfaction level of the residents.

2.3. Post occupancy evaluation

Post occupancy evaluation (POE) focuses on building occupants and their needs, with residents providing insight into the consequences of previous design decisions and the building performance produced. POE is very valuable in all construction sectors, especially health, education, offices,
commercial and housing, where poor building performance will affect operational costs, residents' welfare and business efficiency [18].

Technical elements can be characterised as environmental backgrounds, a kind of "stage set" for activities. These elements include the attributes of survival structure, sanitation, fire safety and ventilation. They are related to health, safety and well-being, and often appear in building codes. Additional elements include the performance of roofs, walls, coatings, lighting, acoustics and environmental control systems, including heating and ventilation Preiser [19].

Functional performance elements discuss functionality and the level of efficiency in building features and facilities. These elements are directly related to the activity in the building Preiser [19].

Behavioural elements relate to the perceptions and psychological needs of building users and how these interact with facilities Preiser [19].

3. Methodology

3.1. Sampling and data collection
In this study, primary data is data obtained from a questionnaire. While secondary data are obtained from the literature. The questionnaire is distributed to residents according to the number of respondents who have been determined. Sample size meets the required statistical parameters recommended by Arikunto (2010). Samples can be taken between 10% and 15% or 20% and 25% of the population. Therefore, the number of samples taken is 30% of the population, which is equal to 23 samples.

This research aims to develop a satisfaction model using structural equation modelling with partial least squares regression and to test the impact of technical, functional and behavioural satisfaction indicators on the overall customer satisfaction for high-rise public housing residents.

3.2. Measurement and data analysis
The questionnaire design based on POE consisted of three elements, namely, technical, functional and behavioural satisfaction indicators, adapted from Preiser [19]. The questionnaire items were developed based on previous studies that employed similar measurements.

A total of fifteen indicators under the element of technical satisfaction as the first construct were adapted from Cho [20], Khair [1], Mustafa [21] and Ibem [22]. A total of 34 criteria were later developed.

The second construct of functional satisfaction indicators was measured using three indicators adapted from Mustafa [21], Ibem and Aduwo [13], Cho [20] and Khair [1]. From the three indicators, the questionnaire was developed using 18 criteria.

The behavioural satisfaction indicators were adapted from Ibem and Aduwo [13] and Cho [20] with ten indicators and 21 criteria for the questionnaire.

| Table 1. Indicators, sub-indicators and questionnaire criteria. |
|---------------------------------------------------------------|
| **Element** | **Indicator** | **Sub-indicator** | **Reference** | **No.** | **Criterion** |
| Technical | Design quality | Zoning | [20] | 1 | Comparison between private and shared spaces |
| | | Size | [1] | 2 | Movement in private space (bedroom and bathroom) |
| | | | | | Movement in shared space (living room, kitchen and dining room) |
| Element        | Indicator        | Sub-indicator                          | Reference | No. | Criterion                                                                 |
|----------------|------------------|----------------------------------------|-----------|-----|----------------------------------------------------------------------------|
| Design quality | Environmental    | friendly design                        | [20]      | 4   | Green open space is available in sufficient quantities                     |
|                | Architectural    |                                        |           | 5   | Green open spaces have several types of plants and support a wider ecosystem (if any) |
|                |                  |                                        |           | 6   | Flats are friendly to the environment                                      |
|                | Temperature      |                                        | [21]      | 7   | Quality and presentation of walls, floors, windows and doors               |
|                | Humidity         |                                        | [1]       | 8   | Flats attract and blend with the surrounding environment                   |
|                |                  |                                        |           | 9   | Flats are divided into specific themes and have unique designs             |
|                |                  |                                        |           | 10  | Flats have the convenience of a shared room to hold joint activities       |
|                |                  |                                        |           | 11  | The centre of the socialising area is easily seen from the entrance access |
| Technical      | Indoor Environmental Quality | Temperature | [21] | 12  | Natural light during the day                                               |
|                | Humidity         |                                        |           | 14  | Roads for pedestrians are protected (from heat, rain and so on)            |
|                | Indoor Environmental Quality | Ventilation |           | 15  | There is a special place protected from outside weather                   |
|                | Indoor Environmental Quality | Air quality       |           | 16  | Humidity in the room                                                       |
|                | Indoor Environmental Quality | Acoustic comfort | [21] | 17  | Outdoor air humidity                                                       |
|                | Indoor Environmental Quality | Lighting          | [21]     | 13  | The number of windows is enough for each room                              |
|                | Safety           |                                        |           | 18  | The air around the environment feels fresh                                 |
| Health and Safety | Safety       |                                        | [20]      | 19  | Pollution that affects the unit/location                                   |
|                | Safety from      |                                        |           | 37  | Availability of early warning tools                                        |
|                | dangerous animal |                                        |           | 38  | Availability of Standard Operating Procedure (SOP) and socialisation       |
|                | Safety from crime|                                        | [22]      | 39  | Availability of first aid kits                                             |
|                |                  |                                        | [1]       | 40  | Shape of the building design is not harmful                                 |
|                |                  |                                        |           | 41  | Emergency stairs are easy to access                                        |
|                |                  |                                        |           | 42  | Regulations regarding dangerous pets                                       |
|                |                  |                                        |           | 43  | Availability and completeness of monitoring tools                          |
|                |                  |                                        |           | 44  | Availability of panic button access                                        |
| Element      | Indicator                  | Sub-indicator       | Reference | No.  | Criterion                                                                 |
|--------------|---------------------------|---------------------|-----------|-----|---------------------------------------------------------------------------|
| Technical    | Health and Safety         | Hygiene facilities  | [20]      | 45  | Clean flat apartment area                                                |
|              |                           |                     |           | 46  | Flats are good in terms of physical appearance                           |
|              |                           |                     |           | 47  | Routinely cleaning the environment                                        |
|              |                           |                     |           | 48  | Security is sufficient and well trained                                    |
|              |                           | Security            |           |     |                                                                           |
|              | Service provided          |                     | [21]      | 24  | Availability of access for disabled people                               |
|              |                           |                     |           | 25  | Number and location of access points for disabled people, parents, children and pregnant women are numerous and well distributed |
|              |                           |                     | [13]      | 26  | Quality and availability of water and electricity supply                  |
|              |                           |                     |           | 27  | Availability and conditions of corridors, stairs and elevators           |
|              |                           |                     | [1]       | 28  | Connectivity between spaces and outside access is good without dead-end access |
|              |                           |                     | [20]      | 29  | Connectivity between social spaces is sufficient and good                |
|              |                           |                     |           | 30  | Disposal of waste water                                                  |
|              | Management                |                     | [13]      | 31  | Management involves residents and good rules                             |
|              |                           |                     |           | 32  | Flat towers implement a good security system at all times                |
|              |                           |                     |           | 33  | Regularly planned programs of joint activities                           |
|              |                           |                     | [20]      | 34  | Shared open spaces can be used by outsiders by complying with applicable rules |
|              |                           |                     |           | 35  | Use of shared facilities is free of additional costs                     |
|              |                           |                     | [1]       | 36  | Good and fast handling of complaints                                      |
|              | Mobility means            |                     |           | 71  | All access is easy to see                                               |
|              |                           |                     |           | 72  | Pedestrian friendly                                                      |
|              |                           |                     | [20]      | 74  | Can easily access public transportation.                                 |
|              |                           |                     |           | 75  | Can be accessed by two-wheeled vehicles                                  |
|              |                           |                     |           | 76  | Can be accessed by four-wheeled vehicles                                 |
| Element | Indicator | Sub-indicator          | Reference | No. | Criterion                                                                                                                                 |
|---------|-----------|------------------------|-----------|-----|--------------------------------------------------------------------------------------------------------------------------------------------|
|         |           | Recreational facility  | [13]      | 53  | Recreational facilities are available in good and well-maintained conditions                                                               |
|         |           | Shopping facility      |           | 54  | Shopping places are available in close proximity                                                                             |
|         |           | Medical / Healthcare   |           | 55  | Close to health centres for all ages                                                                                             |
|         |           | Work opportunity       |           | 56  | Business and job opportunities around flats                                                                                     |
|         |           | Place of worship       |           | 57  | Places of worship are available in close proximity                                                                               |
|         |           | Place of worship       |           | 49  | Place that is able to provide good memories                                                                                     |
|         |           | Place of worship       |           | 50  | Supporting the historical value of the surrounding environment                                                                    |
|         |           | Place of worship       |           | 51  | Unique nature so that it becomes the goal of broader scale activities (e.g. the centre of the Republic of Indonesia's anniversary activities) |
|         |           | Communal place         |           | 58  | Flats have seating in a shared gathering room with good conditions and sufficient quantities                                             |
|         |           | Communal place         |           | 59  | Shared spaces support interaction and increase the familiarity of fellow residents                                                   |
|         |           | Communal place         |           | 52  | Flat space can accommodate several types of activities                                                                          |
|         |           | School                 |           | 60  | Schools are available in close proximity                                                                                         |
|         |           | School                 |           | 61  | Socialised the existence of a flat before it was built                                                                           |
|         |           | School                 |           | 62  | Socialised the progress of the flat when it was built                                                                           |
|         |           | Communication prior    | [20]      | 63  | Socialised completion of development                                                                                            |
|         |           | Communication prior    |           | 64  | Well informed before occupying or buying a unit                                                                                 |
|         |           | Communication prior    |           | 65  | Information centre is easy to see and well maintained                                                                          |
|         |           | Communication post      |           | 66  | Have a special marker for this flat                                                                                             |
|         |           | Communication post      |           | 67  | Entrance access and directions can be seen both inside and outside the flat                                                      |
4. Results and discussion

4.1. Demographics

Respondent data obtained from the results of the questionnaire, consisted of 69.6% women and 30.4% men. In addition, most respondents had the latest undergraduate (S1), diploma three (D3) and high school (SMA) education. Overall, 56% had a S1 education background with the rest equally segregated to 22% D3 education background and 22% with an SMA education background. The age of the respondents varies greatly from the age of 26 to 65 years.

4.2. Structural model

The results of the questionnaire were calculated using the structural equation modelling - partial least square (PLS) method and using SmartPLS 3.2.8 software. All variables are mapped into the SmartPLS according to the initial modelling scheme, with all independent variables having a value or influence on the dependent variable.

Based on test reliability and validity, a total of 14 indicators are omitted due to low indicators of composite reliability (CR) and average variance extracted (AVE) values. The process of reducing the variable in the initial phase scheme is achieved step by step with SmartPLS calculation to obtain the actual model. At every step, indicators will be again omitted should the values of CR and AVE still be low. This is achieved until the CR and AVE values are indicated to be good.

The final results of the SmartPLS (see figure 1) supported three hypotheses that all three elements (technical, functional and behavioural) have a positive influence on the satisfaction of residents in the premises.

Figure 1. Resident satisfaction model of Pasar Jumat high-rise public housing.
4.3. Conclusion

Based on the model findings, this research established that the relationship quality has a more positive influence from the behavioural element (44.5%) compared to the other two elements. This study indicates two major factors to be considered for the next high-rise public housing planning. First, the location of the high-rise public housing plays an important role in influencing the resident satisfaction. Second, high and intensive communication or information exchange between management and residents also highly influences resident satisfaction. This indicates a high desire from residents in involvement in managing their residence.

The functional element with a 38.6% positive influence towards residential satisfaction indicates that the residents are highly concerned with the availability of access for disabled people, the number and location of access to disability, parents, children, pregnant women to be quite numerous and well distributed, quality and assurance availability of water and electricity supply, availability and conditions of corridors, stairs and elevators, connectivity between spaces and to outside access is good without dead-end access, connectivity between social spaces in the building is sufficient and good, and residents are apparently concerned by the means of disposal of waste water. Managerial aspects also give high impact to the functional element. Good rules enforced by management are likely to give assurance to the smooth operation of the building.

The technical element showed only a 15.4% positive influence towards resident satisfaction. This result was not expected, since the technical element was anticipated to be the main element influencing resident satisfaction. The size of the unit that results in the ability for the resident to do activities in the unit is one of the factors in the technical element that concerns the resident, in-line with previous studies carried out in other countries. Safety is also a major consideration for the residents, with a focus on the following factors: availability of early warning tools, availability of SOPs and socialisation, availability of first aid kits; no harmful design of the building; easy access to emergency stairs.

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