A framework for mapping stakeholders interests related social sustainability in residential building

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Abstract. Dwelling is the primary necessity of every human being. Population growth and urbanization movements without being matched by land availability in urban areas make the need for residential buildings higher. Land use from horizontal to vertical patterns gives not only advantages but also disadvantages. Buildings need to adopt sustainable construction concepts to provide maximum benefits in short as well as long term throughout their life cycles. Social sustainability is one aspect of sustainable development that has a relationship with community needs. The different roles of each stakeholder make them have a different interest too and very important to fulfil it, so it is necessary to identify each stakeholder’s interest. Commonly used method only indicating which stakeholders or criteria are more significant separately does not explain how stakeholders can influence it. To bridge the research gap, this paper aims to propose a framework that can analyze stakeholders’ influence to achieve social sustainability. The result of paper is a model using two-mode social network analysis to map stakeholders and their claims relating to social sustainability in residential buildings. The model can show the importance of the social sustainability criteria and stakeholders who have a significant role and should be prioritized more comprehensively.

1. Introduction
Housing is a basic need for everyone and often defined as places or buildings where people live or abode. More than that, housing is among basic social conditions that defines the quality of life and well-being of people and places. It is a place where part of relationships between society and environment supports various human activities[1]. Over time, population growth and urbanization movements continue to rise, and those cause increased density in a city. To meet the basic human need for dwelling with limited land availability, the pattern of urban development has changed from horizontal spread to vertical growth. The use of less area to be built residential buildings can provide more rooms for green spaces and parks. The existence of residential buildings has many benefits as well as negative impacts on residents or people who live nearby. Space is now separated by different levels of the floor affecting the quality of social interaction among residents, and it can reduce social bonds such as lack of caring and sharing. In connection with that, it is crucial to ensure buildings can provide maximum benefit and reduce negative impact during their life cycles.

The concept of sustainable development (SD) is quite relevant to adopt in construction projects to achieve success. There are three main aspects known as the triple bottom lines of SD, including: economic, environmental, and social aspects [2]. So far, social aspects have not been developed much in construction project management, in contrast to the two other aspects that have received more
attention. The aspect of social sustainability is essential to be realized in project implementation so that it can provide long-term benefits for the wider community [3].

Stakeholders can be defined as a group or individuals who can affect or be affected by the decision to achieve organizational goals [4]. Added by [5], stakeholders in the project have interests and expectations on project performance. Therefore, different expectations on each of their interests need to be managed properly so that the actual results can be appropriate and provide stakeholders satisfaction [6]. The satisfaction of stakeholders is one of the project success criteria [7]. Failure to respond and meet community expectations can cause stakeholder opposition which can lead to project failure [8], [9]. According to [10], achieving the product’s customer satisfaction is more important than meeting the specifications of the project. The Sydney Opera House is an example of a project that considered success. The project took three times longer than the planned time and almost five higher than the budgeted, but it becomes the Australia’s most famous landmark [11]. However, before satisfying the stakeholders, the most fundamental thing to do is to identify the interest of each stakeholder.

Most previous studies analyze the importance of stakeholders and social sustainability criteria that should be prioritized separately and do not see the relationship between them. Based on these conditions, this paper proposes a framework model by applying social network analysis (SNA) to visualize stakeholders’ interests by connecting them with appropriate social sustainability criteria in residential buildings in the operational phase, which is the longest phase in project life cycle and where the project has become a product. It is hoped it can provide complete information that helps in formulating solutions to evaluate and improve the social sustainability performance in residential buildings.

2. Literature review

2.1. Sustainability concept

SD is defined as meeting the needs of the current generation without sacrificing the ability of future generations to meet theirs [12]. In addition, [13] defines SD as the improvement of the quality of human life while living within the carrying supporting ecosystem capacities. Extensive research and discussion on the concept of SD produce three fundamental aspects to be balanced, namely economic, environmental, and social aspects.

For decades, construction industry practitioners worldwide have been aware that their activities can negatively affect communities and environment [14]. Sustainable construction (SC) should be applied to minimize the negative impacts. [15] has identified several key features of SC as follows: (1) Considering the life cycle of project; (2) Integration of all three aspects namely: environmental, social and economic; (3) Considering non-technological as well as technological solutions, which means achieving SC does not fully use technology; (4) Considering the needs of present and future stakeholders.

Sustainable housing is not simply as a green building viewed in resource-saving but socially-enhancing and environment friendly which is integrated into the comprehensive urban/settlement system [1]. [16] stated that aesthetic and structural aspects are not the only basic considerations when providing a house but also the need to pay attention to aspects related to resident, cultural, social, and economic values of a society.

2.2. Social sustainability

Social sustainability is about to satisfy human needs and being maintained over long periods of time regarding social justice, human dignity, and participation that are fulfilled [17]. In the context of construction, [18] describes the principles of social sustainability are improving the quality of human life, making provision for social self-determination and cultural diversity, protecting and promoting human health, implementing skills training and capacity enhancement of disadvantaged people, seeking equitable of social cost and benefit, and seeking intergenerational equity. Social sustainability has a different perspective with social impact assessment (SIA). SIA has the tendency to eliminate the negative impacts [19]. Meanwhile, social sustainability aims to deliver maximum benefits and to avoid negative impacts in achieving satisfaction and promoting the success of the project [20].
Several studies have been conducted to consider the social context in residential buildings. [16] stated that there are six categories such as cultural, heritage, indoor environment quality, health and well-being, safety and service quality, accessibility that are considered in providing buildings. Other studies [21] develop several criteria including: safety, security, sense of belonging to a place, comfort, and aesthetics. [22] develop the indicator that is divided by two, namely: functional, aesthetic & innovative design and user comfort & safety. The other perpectives say that accessibility to public facilities and emergency, crime prevention and safety, and traffic calming are required to be considered in providing buildings [23].

2.3. Previous methods
[24], [25], [26] and [27] use mean analysis to rank the most important attributes to achieve social sustainability in construction industry. Other methods used by [16] and [22] are pair wise comparison to determine the weight of the attributes. Furthermore, [28] and [29] develop fuzzy logic to define linguistic scale to get important weight of social sustainability criteria. [30] combines pair wise comparison and fuzzy logic to get more objectivities of importance indicators. [24] suggests that social sustainability should fully reflect the perspective of the stakeholders in a project. Moreover, [3], [19] and [31] have started the concept of social sustainability using SNA that can be reflected by managing the needs and interests of different stakeholders but not yet specific to residential buildings.

2.4. Social network analysis (SNA)
SNA is a methodology to analyze the structure of social relations in the group by interaction and interrelationship (ties) among the actors (nodes) [32]. SNA has been widely used in construction project management because it can provide a relationship structure and a lot of information that are illustrated in the graph [33]. There are two kind networks of SNA, i.e.: one-mode and two-mode networks. Unlike one-mode network which only links the actor to actor, the two-mode network can analyze the relationship between actors and their associated attributes. The steps of two-mode SNA mainly involve [33]:
1. Identifying nodes and boundaries of the network
2. Linking the relationships
3. Visualizing and projecting the network
4. Analyzing the network
5. Finding the results

3. Proposed framework
The proposed framework in this paper is using social network analysis (SNA) to map stakeholders and their interests relating to social sustainability in residential buildings. The step process of the network model is presented in figure 1. The term usage of ‘criteria’, ‘indicators’, and ‘attributes’ is used interchangeably.
3.1. Identifying the nodes

The first is to identify the nodes to form boundaries on the network. In the two-mode network, there are two types of nodes. In this paper, it consists of stakeholder groups and the attributes of social sustainability in residential building context. The stakeholder groups will adopt stakeholder classification by [19] categorizing into three communities, namely industry, user, and neighbourhood community. Industry communities are people who provide or operate the buildings, such as owners, facility managers, and operational staff/employees. Users are people who use the buildings, such as residents and visitors, while the neighbourhood is the people who live nearby and/or are affected by the buildings, such as residential neighbours, commercial neighbours and who use the path and road in the surrounding areas.

Based on the literature review, 22 indicators were proposed for the social sustainable criteria that might be appropriate for residential buildings as shown in table 1. It is important to perform a preliminary survey to verify the research variables by interviewing experts. Likert scale from 1-5 can be used to calculate the attribute relevancy based on experts’ opinion in which scale 1 represents very irrelevant variables and scale 5 represents very relevant ones. The attributes were considered relevant if the mean score results of opinions from experts are larger than or equal to three (≥ 3) because this value is the middle score between 1 to 5 [34].

| No. | Criteria | Source |
|-----|----------|--------|
| 1   | The building gives a sense of security | [16], [21]–[23] |
| 2   | The building gives a sense of safety | [16], [21]–[23] |
| 3   | The building pays attention to health from pollution/environmental problems | [16], [19], [22], [35] |
| 4   | The building provides a physical comfort | [19], [21], [25] |
| 5   | The building provides a local job opportunity | [25], [36], [37] |
| 6   | The building provides economic benefits for the surrounding community | [20], [25], [35] |
| 7   | Stakeholders are involved in the decision-making process | [20], [19], [25], [35] |
| 8   | Stakeholders’ conflicts can be resolved | [37] |
| 9   | Easy communication and information exchange among stakeholders | [19] |
| 10  | The surrounding community does not feel disturbed by the buildings | [35], [36] |
| 11  | The building respects the cultural values of the surrounding community | [16], [19] |

Figure 1. Process of the network model
The building provides parking area [19]

The building provides proper traffic management [19], [22]

The building provides an easy access to public facilities [16], [22], [23]

The building provides an easy access to emergency facilities [22], [23]

The building provides an easy access to the disabilities [22]

The building creates a sense of place [21]

The building can be a place for social interaction [21]

The building pays attention to aesthetic aspect and functionality [22], [25]

The building provides a communal open space area [22]

The building provides a private open space area [16], [22]

The building provides a visual privacy area [16]

3.2. Linking the nodes
The structure of SNA consists of nodes and links. Links are the representation of interaction and interrelationship among the nodes [32]. The questionnaire will be distributed to stakeholders who have been identified at the previous stage. Stakeholders will choose attributes that are interests that must be met in residential buildings related to social sustainability that has been assessed by experts. If the stakeholders give a value of 1 to the attribute, it means that the attribute is their interest; otherwise if they give a value of 0 then the attribute is not their interest. The answers from the stakeholders are collected and made into a two-mode matrix. Equation 1 is shown as the matrix formulation.

\[ X = [UA]U_{iA}A_{n,m} = \begin{cases} U_{i,j}A_{n,m} = 1, & \text{if related} \\ U_{i,j}A_{n,m} = 0, & \text{if not related} \end{cases} \]  

where:

X = Two-mode matrix between stakeholders (A) and social sustainability criteria (U) in which \( U_{i,j}A_{n,m} = 1 \), if stakeholders i,j have interest criteria n,m and \( U_{i,j}A_{n,m} = 0 \) if otherwise.

3.3. Network visualization
This matrix X is an input of the visualization of the network. Network visualization can be illustrated using applications such as UCINET, NetMiner, NetDraw, Pajek, etc [38].

3.4. Projecting two-mode network
In addition to analyzing relationships in the network, SNA can be used to find out how big an actor’s role is or the level of importance of attribute in the network is. The two-mode matrix needs to be projected into one-mode matrix before the analysis. There are 2 types of one-mode matrix i.e., the matrix of relationships between stakeholders and other stakeholders, and the matrix of relationships between criteria and other criteria. The two-mode will be converted into one-mode network by using equations 2 and 3 [39].

\[ [AA]_{nm} = X^T.X \]  

\[ [UU]_{ij} = X.X^T \]  

where:

\( X^T = \) The transpose of matrix X.

\[ [AA]_{nm} = \) One-mode matrix that represents the relations between stakeholders.

\[ [UU]_{ij} = \) One-mode matrix that represents the relations between criteria.
3.5. Network analysis
The topology measurement of node relation used is centrality measurement. Several kinds of centrality commonly used are degree, betweenness, and eigenvector centrality. Degree centrality is defined as the importance of node which refers to how many nodes are directly connected [40]. Betweenness centrality is defined as the number of time nodes passed by the shortest path between 2 nodes that are not directly linked [40]. Eigenvector centrality is defined as the importance of node which has higher score when the neighbours node also has high connection [33]. The highest value can be interpreted as an important node of the network.

3.6. Result and discussion
After the results are obtained in the previous step, the result is discussed to get the findings of the relations of networks, the importance of the criteria and stakeholder prioritization, so it can help the decision-makers in formulating solutions to evaluate and improve the building performance and management of stakeholders to ensure social sustainability. The illustration of the flowchart network is presented in figure 2.

![Network Analysis Diagram](attachment:image.png)

**Figure 2.** Illustration of network analysis model flowchart

4. Discussion
Implementing social sustainability in project construction can deliver the project’s success. Satisfying the social need of stakeholders indicates that the project has been implemented well. Based on literature review that was conducted, there are 22 criteria of social sustainability in residential buildings. Each criterion cannot satisfy all stakeholders because of differences in needs and interests. Hence, this research proposes a framework model to achieve social sustainability more comprehensively. The model creates a network that connects stakeholders with social attributes and shows how stakeholders can influence social sustainability.
5. Conclusion and recommendation
Based on the background of the problem and the literature review conducted, this study discusses about social sustainability that considers the needs and interests of different stakeholders in residential buildings which are limited. Therefore, this study proposes the framework model to map stakeholders’ interests relating to social sustainability criteria. The paper also shows the steps to use the model to determine the importance of 22 criteria based on literature review and the stakeholders that have major roles in residential buildings in the operational phase. The hope is that this research can contribute to evaluate and improve the residential building performance in terms of sustainability, especially in the social aspect to provide maximum benefit.

In further research, the proposed model needs to be tried on the actual buildings as a case study and should pay attention to each phase of the project from initiation to demolition. The weight of importance that can be generated in the analysis of the model can be continued to assess the performance and choose alternatives to decision making.

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