Energy Efficiency Performance in Refurbishment Projects with Design Team Attributes As A Mediator: A Pilot Study

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Abstract. The Energy Efficiency (EE) plays an important role over the building life cycle and the implementation of EE in refurbishment projects has a significant potential towards the reduction of greenhouse gas emissions. However, the involvement of the design team at the early stage of the refurbishment projects will determine the success of EE implementations. Thus, a pilot study was conducted at the initial stage of the data collection process of this research to validate and verify the questionnaires.

Keywords: Energy Efficiency, Refurbishment projects, Design team attributes

1. Introduction
The Energy Efficiency (EE) improvement of building is one of the main decisions for saving primary energy and reducing greenhouse gas emissions [1]. The EE plays an important aspect over the building life cycle and energy efficient refurbishment in buildings has an enormous potential for energy saving towards the reduction of greenhouse gas emissions [2]. Elforgani & Rahmat [3] study revealed that the main environmental impact of a building is initiated during the early design stage. The early decisions made during design phase, will give impact on the overall project performance [4] and the effectiveness of a building to consume energy throughout its running life cycle is mainly determined at the early design stage [5].

2. Energy Efficiency Design Performance in Refurbishment Projects
In Malaysia, the government has been supporting the energy efficiency issues based on several initiatives including the regulatory matter to integrate the environmental issues into decisions during the design stage. These initiatives include The National Green Technology Policy (NGTP) in 2011, GBI (Existing Building Rating Tool), and Energy efficiency programmes such as Malaysian Industrial Energy Efficiency Improvement Project (MIEEIP), Small Renewable Energy Power Programme (SREPP and Building Energy Efficiency Programme (BEEP). All these efforts by the government showed the commitment towards energy efficiency development [6]. Nevertheless, the current initiatives functioning to encourage the energy efficiency building in Malaysia construction industry have been left behind schedule [7]. Reza et al. [8] stated that not many developers and designers in Malaysia are keen to move forward in the sustainable construction that include energy efficiency but instead remain with the conventional technique of construction even with the recent support from the government to build more sustainable buildings. Zainul Abidin [9] stated that there is a modest figure of sustainable projects in Malaysia and this showed that sustainability movement being slowly implemented among construction players and the energy efficiency movement is still at the early stage.
3. Design Team Attributes
On the other hand, Horman et al., [10] pointed out that the integration working manner among the design team at the early stage of the project will determine the success in the energy efficient project performance. In refurbishment projects, according to Rahmat [11] the early design stage of the design team involvement will improve the project performance. Thus, more attention should be emphasized at this early point. To embrace high performance in energy efficient design the design teams have to work in an integrated manner with the right attributes. The good attribute of design team will enable them to interpret EE requirements [12]. Besides, the attributes of design team will influence the building refurbishment project performance [13]. Therefore, the attribute of the design team will determine the overall EE project performance and should be clearly identified.

4. Research Methodology
A pilot study was conducted for the data collection process. The questionnaires were distributed to the Architects, Electrical Engineers and Mechanical Engineers in the construction industry to validate and verify the questionnaire. By doing the pilot study the validity and consistency of the questionnaires can be confirmed. Wilson & McClean [14] pointed out that pilot study is important to look at the accuracy of the items in the questionnaire, as a guideline and to avoid confusion or difficulty in wording. Besides, the pilot study is important to receive a feedback on the validity of the items in the questionnaire, to get feedback on the presentation of the questionnaire and to get feedback on the format of the questionnaires which includes; layout, sectionalising, numbering or new items in the questionnaire. The sampling of the questionnaires was distributed through the convenience sampling. This was done in the seminar on Energy Efficiency which was organized by Building Sector Energy Efficiency Project (BSEEP). Convenience sampling refers to the collection of information from members of the population who are conveniently available to provide it [15]. In this research convenience sampling may be the only choice available since the lack of respondents for refurbishment projects who involve in EE implementation. Besides, the convenience sampling is only meant for pilot survey of this research. In addition, the convenience sampling is only meant for pilot study of this research. During pilot study phase, the questionnaires were distributed to all participants in the seminar. 50 questionnaires were distributed to the participants. However, only 23 questionnaires were valid to be used for analysing purposes. The questionnaire survey was divided into six sections which includes of general information, project information, design team attributes, and energy efficiency performance. Several different forms of scale were included in the questionnaires such as multiple-choice questions, five points Likert scale questions. To obtain higher response rate, the questionnaires are designed to be only four pages long. The questionnaires were developed based on the sources from many literature reviews involving various authors.

5. Data Analysis And Discussion
Based on Table 1, the majority of 82.6 percent of the respondents were engineers. These included of 39.1 percent were electrical engineers and 43.5 percent were Mechanical Engineer. The rest were architect (17.4%). Based on Table 1.2, almost half (47.8%) of the respondents had more than 10 years of experience in the construction industry. Those with 6 to 10 years’ experience made up about one-third of the sample (34.8%). From these 23 respondents, about 60.9% involved in less than 5 refurbishment projects while only four of them involved in more than 15 refurbishment projects.

| Designation       | Percentage (N=23) |
|-------------------|------------------|
| Architect         | 17.4             |
| Electrical Engineer | 39.1            |
| Mechanical Engineer | 43.5           |
| **Total**         | **100.0**        |
Table 2. Number of refurbishment projects involved

| Refurbishment projects (N=23) | Percentage |
|-----------------------------|------------|
| less than 5 projects        | 60.9       |
| 5 to 10 projects            | 21.7       |
| 11 to 15 projects           | -          |
| more than 15 projects       | 17.4       |
| **Total**                   | **100.0**  |

Most (65.2%) of the refurbishment projects displayed in Table 3 had a contract value of less than RM 10 million. Only two refurbishment projects had a contract value more than RM 50 million while another six refurbishment projects companies managed to secure contract value between RM 11 million to RM 50 million. Thus, this pilot study has enabled to find of projects of varied size which would help produce a comprehensive result. The type of buildings involved for refurbishment project were mostly office (60.9%) and residential (30.4%). The percentage was calculated from multiple responses where in this question, the respondents can answer more than one. Apart from office and residential, industrial (13.0%), education (13.0%), hotel (8.7%) and shop (4.3%) were also involved (Table 4).

Table 3. Contract Value of Refurbishment Project

| Contract value (RM) | Percentage (N=23) |
|---------------------|-------------------|
| less than RM2 million| 30.4              |
| RM2-10 million      | 34.8              |
| RM11-50 million     | 26.0              |
| more than RM50 million| 8.7            |
| **Total**           | **100.0**         |

Table 4. Type of Building of Refurbishment projects

| Type of building | Percentage (N=30) |
|-----------------|-------------------|
| Residential     | 30.4              |
| Office          | 60.9              |
| Industrial      | 13.0              |
| Hotel           | 8.7               |
| Shop            | 4.3               |
| Education       | 13.0              |
| **Total**       | **100.0**         |

Table 5. Type of procurement system

| Type of building | Percentage (N=23) |
|-----------------|-------------------|
| Traditional     | 43.5              |
| Design and Build| 52.2              |
| No answer       | 4.3               |
| **Total**       | **100.0**         |

Table 6. Type of Client

| Type of building | Percentage (N=23) |
|-----------------|-------------------|
| Private         | 65.2              |
| Public          | 34.8              |
Based on Table 5, the type of procurement system was almost equal between traditional (43.5%) and design and build (52.2%). Table 6 showed majority of the type of client was from the private sector (65.2%) compared to public sector (34.8%). Only 8 out of 23 refurbishment projects contained Green Building Certification. From these 8 projects, 5 had GBI, one had Green Mark and another one had LEED (Table 7). In terms of percentage of services work of the total contract value, 65.2% were between 21% to 40% (Table 8).

Table 7. Green Building Certification

| Type of building | Percentage (N=23) |
|------------------|-------------------|
| Yes              | 34.8              |
| No               | 65.2              |
| Total            | 100.0             |

Table 8. Percentage of services work of the total contract value

| Type of building | Percentage (N=23) |
|------------------|-------------------|
| 0%-10%           | 13.0              |
| 11%-20%          | 21.7              |
| 21%-30%          | 30.4              |
| 31%-40%          | 34.8              |
| Total            | 100.0             |

Table 9. Contract value and duration of the refurbishment project

|                      | Min        | Max        | Median     |
|----------------------|------------|------------|------------|
| Original contract value | RM0.5 million | RM100 million | RM6 million |
| Final contract value  | RM0.5 million | RM100 million | RM8 million |
| Original contract duration | 10 weeks | 96 weeks | 24 weeks |
| Duration for extension of time | 0 weeks | 144 weeks | 15 weeks |

Table 9 summarizes the contact value and duration of the refurbishment projects. The original contract value was range from RM500, 000 to RM100 million with median value of RM6 million. This median value indicates that half of the companies had original contract value of less than RM6 million while the other half had value of more than RM6 million. The final contract value had the same range as the original except that the median value was slightly higher which is RM8 million. The duration for original contract value was range from 10 weeks to 96 weeks with the median of 24 weeks. There were companies who did not ask for time extension for the refurbishment projects. The maximum duration for extension of time was 144 weeks with half of the companies requested for less than 15 weeks of extension.

In measuring the consistency of a measure and to ensure that the items are assessing the same underlying construct, reliability analysis for Refurbishment Project Complexity, Design Team Attributes and Energy Efficient Performance were conducted. The data collected from the pilot study was verified through Cronbach’s Alpha coefficient in order to ensure all items in the questionnaire are reliable and can be used for the final questionnaire survey. As a standard of reliability, the minimum acceptable standard value for Cronbach Alpha that is accepted is 0.7. Those above 0.8 represent good reliability and those above 0.90 represent excellent reliability value [16,17].

Table 4 indicates good estimates of internal consistency reliability as the values ranged between 0.92 and 0.95 for each construct. These values are far greater than the minimum level of 0.7, thus the questionnaire items indicate a satisfactory high degree of internal consistency and can be used for further statistical analysis.
Table 10. Reliability analysis

| Attribute                        | Number of items | Cronbach Alpha |
|----------------------------------|-----------------|----------------|
| Refurbishment Project Complexity | 19              | 0.92           |
| Design Team Attributes           | 21              | 0.95           |
| Energy Efficient Performance     | 18              | 0.93           |

6. Conclusion
In conclusion, the pilot questionnaire survey results provided important information about the EE design performance of refurbishment projects in Malaysia. The literature search and survey results showed that thorough studies into the refurbishment were relatively scarce. Thus, more detail study in refurbishment area is needed for Malaysian construction industry in the future.

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