

UNCERTAINTY IN THE DESIGN PROCESS OF REFURBISHMENT PROJECTS

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ABSTRACT

Building refurbishment is an important sector in Malaysian construction industry. High demand for refurbishment is mainly contributed by the increasing number of building physical improvement, extension and extensive repair works. However, refurbishment projects are more difficult to manage compared to new projects. This is due to factors which are called the uncertainty factor, which are inherent in the projects. Therefore, the main objectives of this paper are to present the factors that contribute to the uncertainty and to explain how they affect the performance of design in refurbishment projects. This paper employed triangulation technique, with the combinations of quantitative and qualitative approaches. The study started with the identification of uncertainty factors by literature reviews followed by semi-structured interviews with 21 professional architects and finally a questionnaire survey. The questionnaires were distributed to 234 selected professional architects in Malaysia. The results from 82 completed questionnaires formed a database for the quantitative analysis. This study concluded that the design process of refurbishment projects suffered from the uncertainty whereby variables content of services, structural, design fees and clients' attributes affect the design performance.

Key Words: Design Process, Refurbishment, Uncertainty, Design Performance

1. INTRODUCTION

Refurbishment is one of the most uncertain among the construction projects (Quah, 1988). Majority of completed refurbishment projects suffered from over estimated time and cost. One of the factors contributed to the uncertainty is the design process (Daoud, 1997). Therefore, the identification of factors that contributes to the uncertainty of design process is required because it could affect the performance of refurbishment projects (Rahmat, 1997; Hashim, 2004). By identifying the uncertainty factors, it provided more information regarding the design process of refurbishment projects. Besides, this would be able to assist the designers involved to familiarize on the degree of risk and uncertainty that need to be mitigated in the design process of the projects. In literature reviews, there is no empirical study investigates on the uncertainty factors that affect the refurbishment design performance. Therefore, the main objective of this paper is to identify the uncertainty variables in the refurbishment design process and shows the relationship towards the design performance variables.

2. THE DESIGN PROCESS OF REFURBISHMENT PROJECTS

The design process does not have standard agreed definition. Building design process defined by Hassan (1996) quoted from Baldwin et al. (1999: p 155) as:

“a process that maps an explicit set of client and end-user requirements to produce based on knowledge and experience, a set of document that describe and justify a project that would satisfy these requirements and other statutory and implicit requirements imposed by the domain or the environment” More brief description was given by Baldwin et al. (1999: p 33) who described building design process as:

“A multi-disciplinary process, performed in a series of iterative steps to conceive, describe and justify increasingly detailed solutions to meet the needs of the client”

The definition indicated the design process involved with an inter-discipline and non-linear activities. The involvement of many participants in various disciplines obviously creates difficulties in managing several complex design activities. Design process normally consisted by several stages from scratch until completion of a project. However, there were no standard stages for design process universally accepted by all the architects. The most commonly used for building design process is form RIBA plan of work (RIBA, 1973). In Malaysia, the architects had to follow PAM the ‘basic service work’ the guideline of design process as mentioned in the ‘Architects Act 1967, Act 117 and Rules’ (2004). Malaysian Architects Act 1967 (2004) described the design process encompass of four main stages that are Schematic Design, Design development, Contract Documentation and Contract Implementation and Management. The stages abstracted from the RIBA plan of work model and been modified in order to suit with local projects environment. Therefore, in the definition, the author included the period for the design process as mentioned by the act as follows:

“A multi-disciplinary process, performed in a series of iterative steps to justify total solutions that is of value to the client starting from schematic design to contract implementation and management phase”

3. SEARCH METHODOLOGY

This study designed with the triangulation technique, which consists of quantitative and qualitative approaches. Semi-structured interview were use for qualitative part whereas for quantitative, the postal questionnaires survey has been used for data collection method. In order to get high response rate, the questionnaire was design short and simple that did not take long time for the respondent to answer. The respondents for this study consisted of professional architects who are registered with the Board of Architect Malaysia. 243 architects with refurbishment design experience identified appropriate to participate in the survey. A questionnaire sent to the final list of 243 architects. After filtration made from 98 replied questionnaires, 82 questionnaires found useful for analysis giving response rate about 36 percent. The replied questionnaires represent 82 different refurbishment projects that the contract value is more than RM 500,000.00. This due to clearer pattern on the degree of involvement could be obtained from this size of projects. The demographic profile of the respondents shows in Table 1. The profile shows almost two-third of the respondents were principal architects. The result indicates that nearly ninety-five percent of them had more that 10 years of experience in construction industries.

Table 1: Demographic profile of respondents

| Position | Percentage, N=82 |
|------------------|------------------|
| Principal | 68 |
| Senior Architect | 15 |
| Architect | 10 |
| Others | 7 |

For statistical data analysis, multivariate analysis associative test were use in deriving conclusion of the study.

4. THE MEASUREMENT OF UNCERTAINTY IN REFURBISHMENT DESIGN PROCESS

Uncertainty means that a difference between the amounts of information available to perform a task (Galbraith, 1977). Ward and Chapman (2002) provided definition on uncertainty as something that associated with ‘lack of certainty’ and also about ‘ambiguity’ related with lack of data, detail, structure to consider issue, working and framing assumptions and the sources of bias. Young et al. (1996) said that managing refurbishment projects is managing an uncertain project condition where the situation changed drastically. Data used to guide the refurbishment works were limited and in some cases were not available especially during the initial stage of design process. Therefore, the uncertainty in design process need to be address explicitly since refurbishment design process involved many independent decisions.

Santana (1990) used measurement of project complexity by classified a number of variables such as cost, physical location, impact on natural and social environment, technology, difficulty of access and large number of specialised workers. The measurement was using ten-point scale from 1 ranging to 10 and classify into normal, complex and singular. This method however gave same rating on complexity variables, which indicated similar degree of important of all complexity variables. On the other hand, Rahmat (1997) measured uncertainty in refurbishment planning by identified thirteen dominant project characteristic. This variable named as situational variables that covers uncertainty and complexity in refurbishment planning process. The variables were given five point scale from very low (1) ranging to vary high (5). The approach duplicated by Hashim (2004) who study safety in refurbishment projects.

Some of the approaches used by construction management authors such as Santana (1990) were too broad to claim refurbishment project is uncertain and complex. The situational variables need to be thoroughly discussed before the conclusion could be derived. Therefore, the approach used in measurement of uncertainty in the present study would follow Rahmat’s (1997) approach. The variable would be categorized as ‘Design uncertainty variables’.

5. UNCERTAINTY VARIABLES IN REFURBISHMENT DESIGN PROCESS

Through literatures, the author had identified eight dominant uncertainty variables that associated with the design process of refurbishment projects. The variables are:

- Percentage of Services Design
- Percentage of Structural Design
- Occupancy
- Type of Building
- Ease of Access to The Building
- Client’s Attributes
- Reasonable Design Fees
- Sufficient Design Time Frame

5.1 The Percentage of Services Work to Contract Value

The percentage of services work to contract value contributed to the uncertainty of refurbishment projects. The higher is the proportion of services work, the more problem on accuracy of design expected in refurbishment projects (Stone, 1976). Harris (2006) mentioned that the difficulties in refurbishment works depend on interrelatedness among the building systems. If building services installed concealed to the wall or other building finishes, the more uncertain is the services information to be obtained. In this situation, it involved other related designers such as structural and architectural to get involved in confirming the accuracy of the information. The lack of involvement of the other designers could contribute to unforeseen

site condition during contract implementation period. McKim et al. (2000) mentioned that concealed elements for services part such as electrical wiring coupled with inaccurate as built drawings are major factors contributed to the unforeseen site condition. The late discovery of services information during contract implementation stage leads to many changes in design than what is expected (Slaughter, 2001).

5.2 The Percentage of Structural Work to Contract Value

Slaughter (2001) pointed out the importance of structural works in refurbishment projects. The study revealed that almost two-third of the buildings renovated for the same usage class required changes to the structural system and almost 90 percents of the building being renovated for new usage class required structural alterations. The statement shows majority of the refurbishment projects include structure modifications as their scope of work. Clancy (1995) said that structural refurbishment and repair projects found to be more complicated compared to new build projects. This due to more consideration and prediction of unknown item required to be done. The design works would be more difficult if the scope of work involved demolition and stabilizing the existing structure. CIRIA (1994) highlighted that refurbishment works involved alteration of the existing building structure often required installation of shoring and temporary supports which sensitive and difficult tasks. The usage of temporary supports would influence design time and cost of refurbishment projects. It also usually involved many procedures of investigation such as probing and destructive testing which result to the destruction of architectural finishes as mentioned by Friedman and Oppenheimer (1998).

5.3 Occupancy in Refurbished Building

Daoud (1997) pointed out that concurrent operation by the building users would interrupt the overall flow of refurbishment projects. The sequence of work is difficult to determine when the ownership of building needs to be shared by the occupants with project team. This creates difficulties especially during design development whereby the designers need to decide jointing of the new installation parts especially for services items. Each services system normally forms an integrated network, which runs to the various parts of a building. The design of services works could become highly complicated for refurbishment works when only certain part available at any one-time work, which would affect other parts. Furthermore, Quah (1988) said that refurbishment work in occupied building should not interfere with the normal usage of the buildings. Temporary electrical supply could be connected from generator set to existing services such as air conditioning and boiler during the execution of refurbishment works to avoid any disruption to building users. This however required the designers to do extra work in order to ensure total connected load is sufficient to run the existing services systems. In addition, this approach would lengthen the total refurbishment period and overhead cost (CIRIA, 1994).

5.4 Different Types of Building

NIDO (1987) said the variety type of building indicated different in their degree of uncertainty and problem faced in the construction projects. The uncertainty of design concerning to the different type of building much referred to their statutory requirements, existing use and complexity of the building layout (Naum and Mustapha, 1994). However, Rahmat (1997) discovered that there was no significant different for the variable 'different type of building' for refurbishment projects. Only variables 'access to the site' and 'storage of material' found to be more difficult and smaller for the office type of buildings. The result implies that the type of building provides only a few indications on the degree of uncertainty in refurbishment projects whereby each projects have their own unique problems to handle. Moreover, the Architect Act 1967 and Rule (2004), classified the types of building into three main categories based on the degree of complexity. This reflected the scale of minimum fees paid for the service. Refurbishment work fall under category one, which indicates the nature of work that is difficult. The scale of fees for

refurbishment projects not categorized based on different type of building. This indicated complexity of refurbishment projects is not entirely depends on type of building.

5.5 Ease of Access for Existing Building

The uncertainty of available access to work area caused refurbishment design is difficult compare with new build projects. The Chartered Institute of Building (1987) pointed out that the difficulty of access to refurbishment projects sites could increase the level of uncertainty in refurbishment projects. Since the site of refurbishment projects located inside the existing building, the designers have to consider the available access such as door, window, stair and lift to transfer construction material through its. Refurbishment projects that involved high-rise building might face problem since the available access to the higher floor only through the stairs and lifts. This requires temporary opening to the wall or roof needs to be done for transferring large mechanical equipment goes into the building. Refurbishment projects that involved the installation of big equipment such as cooling tower on top of building might require cranes to assist the process. If the refurbishment projects situated in congested area, it creates problem to locate the crane. Gilleard and Lee (1998) said that the limited access is that one of the factors influences the refurbishment design proposal.

5.6 High Quality of Client Attributes

Lim and Ling (2002) cited that the quality of client's attribute would influence the projects performance. Boyle (2003) maintained that the key successful of design rests much with the clients besides others such as good budget and comprehensive brief. Briefing is a process running throughout the construction projects by which means the client's requirement progressively translated into the reality. Inability of the client to provide adequate brief and input always contribute to additional work and design variations. Poor briefing and breakdown communication always happened when the client is not committed in the projects. Lim and Ling (2002) agreed that the commitment of the clients providing resources such as financial and management supports are important towards the successful of projects. While Tilley and McFallen (2000a) found the lack in commitment by the clients contributed to error occurrence in the design work. A committed client would ensure project resources such as financial are sufficient for a project. The clients should be certain on their financing cash flow requirement when the project started. Delay in payment or payment made not according to the agreement would affect progress of the projects, which leads to inadequate time to produce complete and accurate design (Bresnen & Haslam, 1991). Moreover, the lack of ability of the clients to provide faster decision often creates problem to the projects. Cole (1990) noted that slow authorisation of the clients or indecisive due to poor relationship with the clients the possible consequences to a delay of approval to the proposed design.

5.7 Sufficient Design Time Frame

Cole (1990) highlighted the importance of having sufficient design time to complete design carefully. Time is an essence to the designers especially for gathering all necessary information from various sources. If the time given by the clients is insufficient, the designers would use only available data and assumption based on their experience to finalize the design. In normal circumstances, the designers need extra time for them to do some research works before development of design. Court et al. (1993) said the designers used average 30 percent of their design time to do searching for design information. Boyle (2003) maintained that sufficient time scale is one of the most important factors contributed to successful design. There were many errors found in the design documents if the designers complete it in hurry due to time constraint. Insufficiency of the design time given could adversely affect the morale of the designers, relationship with people, communication inspired, reduced the productivity and attention of detail tend to be slipped. Andi and Minota (2003) mentioned that limited design time given by the client as a factor affects the quality of design documentation output. In adequacy of time could disrupt the designers to have

opportunity to develop drawing details and did coordination on the various aspects of design. As a result, many changes in design occurred during contract implementation stage.

5.8 Reasonable Design Fees

Amount of fees for design works would reflect to the quality of service provided. This would affect the quality of design documentation in construction projects. Daoud (1997) highlighted that the performance of refurbishment projects especially for project completion affected by underpayment for consultant services. This reflects work force allocation for the projects, which affects the productivity of design works. Low design fees would result to the paying of low salaries, which could act as de-motivators to the designers. This may end up with design error, which caused many changes during contract implementation stage. Love et al. (2000) found that one of the reason which errors in design works occurred contributed by low design fees. In addition, limited design fees could cause ‘time box’ task that is fixed time allocated for a task irrespective whether the design document is complete or not. The situation became worst when many tasks performed concurrently that increase the tendency of the designers to make mistake which lead to rework in their work. Tilley and McFallen (2000a) discovered that low design fees contributed to rework in construction projects. On the other hand, the Architects Act 1967 and Rules (2004) mentioned that refurbishment projects fall under category 1, the scale of fees, which is the highest category in the scale. It reflects the degree of difficulties in preparing and managing the design works. The scale of fees presented by the Board of Architect Malaysia is to ensure that all the professional architects would receive reasonable fees in the design works.

6. Data Analysis and Discussion

From the result obtained two type of procurement system involved in the study. Mann-Whitney U test employed to check any different on degree of uncertainty for both type of procurement system used. The result shows there is no significant different on degree of uncertainty for both type of procurement system.

Table 2: The Correlation Matrix between the Uncertainty Variables and Design Performance

| | % Changes of original design during construction stage | % provisional sum to contract value | Time variance | Cost variance |
|----------------------|--|-------------------------------------|---------------|---------------|
| % Services | -.193 | -.317** | -.121 | -.078 |
| % Structural | -.117 | -.319** | -.148 | -.067 |
| Occupancy -schematic | -.056 | -.164 | .077 | .008 |
| Occupancy- | .046 | -.075 | .065 | .148 |
| Type of building | .011 | -.164 | .071 | -.130 |
| Ease of Access | -.070 | -.075 | -.103 | -.036 |
| Client’s needs | -.277* | -.226* | .018 | -.026 |
| Client’s skill | -.079 | -.310** | -.040 | -.061 |
| Client’s commitment | -.282* | -.182 | -.069 | -.019 |
| % Design fees | -.265* | -.067 | -.087 | -.097 |
| Design time frame | -.072 | -0.33 | .045 | .073 |

Notes: * Correlation at 5% significant level; ** Correlation at 1% significant level

To check relationship between uncertainty and performance variables, associative test using Spearman rank correlation coefficient employed in the analysis. The uncertainty variables were recodes ascending from very uncertain to very certain. In contrast, the performance variables recoded descending. Thus, the

result expected to shows negative correlation that indicates greater uncertainty of the uncertainty variable the lower is the performance of the design. The results of the associative test show in Table 2. In the associative test, null hypothesis rejected at 5 percent significant level. The null (H_0) and alternative (H_1) hypothesis set as follows:

H_0 : There is no correlation between the uncertainty variables and the design performance.

H_1 : There is correlation between the uncertainty variables and the design performance.

Structural and services content to contract value shows negative correlations with percentage of provisional sum to contract value. This indicates the highest the content of services and structural in refurbishment design, the higher the amount of provisional sum allocated to the projects. The higher amount of provisional implies greater the degree of uncertainty in refurbishment design due to limited information available during schematic design stage (Rayers and Mansfield, 2001). The plausible explanation here could be the content of structural and services works normally concealed, which could only be confirmed when work started on site. This forces the designers to use their own assumption in order to complete the design (Quah, 1988). The result also implies that it is necessitates for the designer to used special technique such as testing to get information that is more accurate. In addition, greater involvement of structural and services engineers required to increase coordination and obtain accurate information as suggested by Friedman and Oppenheimer (1998).

Under the category of client attributes, 'client's needs' shows association with two performance variables. They are:

- i. The percentage of changes of original design during construction stage
- ii. The percentage of provisional sum to contract value

Negative correlations were detects for both performance variables. The results supported statements by Mitropoulos and Howell (2002) who said that the reasons behind design changes were the clients change their design requirements along the project period especially during contract implementation. The uncertainty of the client requirements also required high allocation of provisional sum in the contract. In addition, a negative correlation detected by variable 'clients skill and knowledge' towards the percentage of provisional sum to contract value. This probably implies that the client with limited skill and knowledge in refurbishment projects do not have ability to provide adequate brief, which required the designers to make more assumption in their design. Due to that, the designers have to provide certain amount of provisional sum to substantiate the uncertainty in client brief. Moreover, a correlation detected for variable 'client commitment' with the percentage of changes of original design during construction stage. The result supports argument by Lim (2002) who emphasise the importance of having committed client towards the projects success. The lack of commitment given for coordination with the architects and other participants induces breakdown communication happened along the design process could be the reason of the appeared result. In overall, four correlations detected by variable clients' attributes imply the significant functions of the clients who involved in managing the refurbishment projects. The client attributes could minimized amount of provisional sum in design and at the same time reduced the tendency of having changes of the original design.

Negative correlation detected for variable design fees with the percentage of changes of design during contract implementation stage. It indicates that reasonable fees received by the architects affect amount of design changes took place during contract implementation stage. The finding supports argument by some of the previous authors such as Tilley and McFallen (2000a). Frequency distribution analysis shows refurbishment projects in the study comprise with high amount of services and structural contents to the contract value. Therefore, more effort is needed by the designers since it is difficult to gather required information concerning with the services and structural parts. The unreasonable fees allocated could induce the designers to use more gut feeling and intuitions in completing their work that caused more error and changes in design.

7. CONCLUSION

Literature review identified eight dominant uncertainty variables, which affects the performance of refurbishment design. Analysis of the result shows there is no significant different concerning to degree of uncertainty for traditional and design-and-build procurement system. However, the result of associative test shows four significant correlations between the uncertainties towards the design performance, which indicate the refurbishment design process suffered form the uncertainty inherent in the projects.

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