



**PLANNING MALAYSIA:**

*Journal of the Malaysian Institute of Planners*

**VOLUME 20 ISSUE 1 (2022), Page 143 – 154**

## **TORNADO FINANCIAL DEVELOPMENT COST ANALYSIS FOR GREEN PROJECT IN MALAYSIA**

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### **Abstract**

In Malaysia, green building has currently become significant as sustainable development. Most of the established developers have incorporated sustainable development in green building projects. Due to the passive evolutionary effects of real estate on the environment and human health, the development and promotion of green buildings for a sustainable environment have become a market trend to attract buyers in this country. Thereby, the qualitative approach methodology is adopted in this study, where a case study has been selected to observe the significant risk impact on the development cost. An in-depth analysis was carried out using a feasibility study, and a discounted cash flow was performed. The simulation runs using tornado analysis to detect the most significant risk affected by development cost. The results indicate that the building cost, mechanical and electrical works, and piling works are the highest risk in developing a green building. Therefore, the client should take extra precautions in green development to monitor the affected cost to minimise project delay and achieve the project objectives. A tornado analysis makes decision-making more explicit by the client. It enables the decision-maker to analyse the risk contributing to the development cost and make more effective decisions.

**Keywords:** Green Development, Development Cost, Qualitative Method and Tornado Analysis

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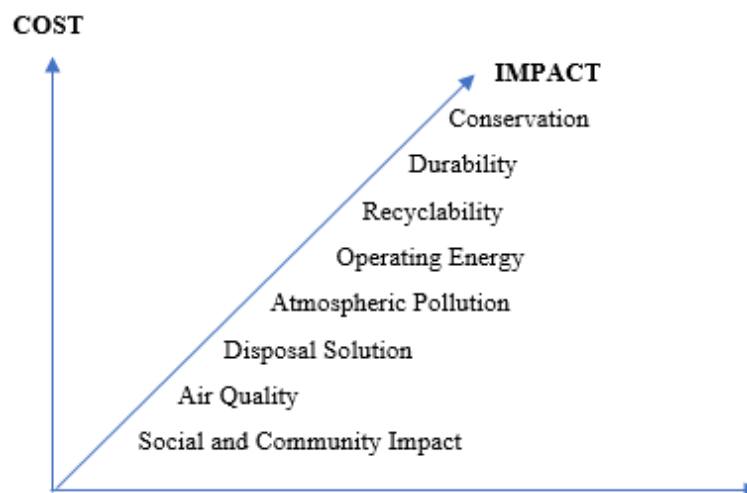
## **INTRODUCTION**

Green building has currently gained significance in development projects in Malaysia. The design and construction of the proposed development for green buildings are required to follow the guideline set up in the Green Building Index (GBI) that has been developed by the Malaysian Institute of Architects (PAM) and the Association of Consulting Engineers Malaysia (ACEM). The proposed project must accomplish the rating criteria for building environmental design and performance in green building development. The six (6) critical criteria include energy efficiency, water efficiency, indoor environment quality, sustainable site planning and management, material and resources, and innovations (PAM) and (ACEM) (April 2009). As confirmed by Li, Yang, He, and Zhao (2014), green buildings have various definitions and rating systems, such as saving energy, material, land, and water resources, indoor environmental quality, and reducing pollution are widely accepted as the general definitive principle. For a development to be recognised as sustainable, the developer should consider the project based on a balanced approach that addresses the environmental, social, and cost issues. According to Finkbener, Schau, Lehmann, and Traverso (2010), green development is capable of covering today's needs for an intact environment, social justice, and economic prosperity without limiting the ability of future generations to meet their needs. The preservation of the natural environment is a prerequisite for a well-functioning economy and social justice. The cost to construct the project embedded with green elements differs from the conventional method. Therefore, the research aims to analyse the element of risk for the financial development costs by using tornado analysis. The tornado analysis is crucial for the clients in decision-making and to analyse the financial development risk in the green building projects.

### **Green Development**

Green development is a real estate concept that reflects social and environmental impacts. The developer should consider the elements of nature, minimise the damage to the ecosystem and resource efficiency in order to conserve energy and the environment. The building they construct, design, and operate should reflect knowledge of sustainability needs (J, Wilkinson, and Sayce (2015). The related whole life cost for green development is crucial. The quantity surveyor should integrate knowledge in the costing method for feasibility appraisal for green development Halil, Ismail, Hasim, and Hashim (2020). To estimate the cost of this type of construction requires skills in terms of design factor, material, the topography of the site area, and the form of the construction that is used. Getting the minimum whole life cost and environmental impact is complex. Figure 1 shows the technique, materials

choices and technologies significantly related to the costs of the construction (Cartlidge, 2009).



**Figure 1:** Shows the technique, materials choices and technologies

Figure 1 shows the elements that contribute to the cost of the projects for sustainability development. The whole life cost contributes to the higher cost of the development that is proposed by the developer. The cost of the development comprises the activities conducted. The expenses include estimation of demand for new buildings types, the design of sites, the design of facilities, the arrangement of short and long term finance for site acquisition, construction, and lastly, the management of the completed buildings (Chau, Leung, & Ng.W.Y, 2015).

### **The Characteristics of Green Development**

The characteristic of Green Development, as revealed by J et al. (2015), are as follows;

- 1) Land use, Urban Form and Urban Quality
- 2) Environmental Protection and Enhancement
- 3) Location and Transport
- 4) Resource Use
- 5) Business and Community Characteristics

### **Land use, Urban Form and Urban Quality**

Urban design for creating space inspires individuals as well as encourages and facilitates safe pedestrians. The plan for the proposed development must

promote longevity and sustainability (Kamaruddin, Mohd Rosmi, Muhamad Halil, Misni, & Marzukhi, 2020). Sites should be designed to meet the needs of the end-users. The concept of building and infrastructure must promote sustainable townships to balance liable neighbourhood and community. An appropriate density for the population is crucial for the developer to consider. Minimising transportation use is vital to preserving the environment from global CO<sub>2</sub> gas emissions. Sustainable sites bring economic advantages by reducing resource use and encouraging social and environmental responsibility, improving human health and social wellbeing (Huo, Yu, Wu, & Jayanthn, 2020).

### **Environmental Protection and Enhancement**

The project's construction in development will create pollution for humans and the environment. The client must take into consideration and care that the development minimises and avoids polluting emissions. At least 33 per cent of greenhouse gas emissions are related to construction activities (Chau et al., 2015).

### **Location and Transport**

Location is a crucial part of successful green development, and access via the various modes of transportation is increasingly important to provide flexibility of use in the future (Nasrudin et al., 2020). The new transportation development is expected to complement the existing transportation systems, and reduce overall traffic density (Narayanaswami, 2017). The researcher added a good example from a case study of Dubai Metro. Dubai Metro proposed transport integration in a green development area, and the system of integration with other city transport is aligned with bus routes.

### **Resource Use**

Energy-Efficient Design for green development is fundamental to improving the resource use for the sustainability of a building. Efficient energy use is a crucial measure to reduce carbon dioxide emissions. (Lu, Tam, & Du, 2020) revealed that low carbon designs can be very effective in lowering building carbon emissions through the reduction of energy consumption or by applying a new material system.

### **Business and Community Characteristics**

The green development design must fulfil all aspects of the business chain and suit every part of community characteristics such as equality and diversity, health and wellbeing, safety and security, and accessibility and diversity (Luederitz, Long, & Von Wehrden, 2013). In designing a sustainable community, it is necessary to consider the social, ecological, and economic

factors. The most important is that green development is offered within a reasonable project budget. The goal is to provide an enjoyable living environment for the residents while reducing pressure on the natural environment as much as possible. Therefore, the above characteristic is crucial for the developer in planning green development for a future project.

### **Tornado Analysis**

The tornado analysis is a powerful simulation tool that captures the static impacts of each variable on the outcome of the model (Mun, 2015). Tornado techniques are used to depict the sensitivity of a result to changes in selected variables in the construction cost. The result is then displayed as a special type of bar graph.

### **Advantages**

- 1) The tornado diagram is relatively easy to create.
- 2) Sensitivity of risk occur can be identified at the early stage in the construction project.

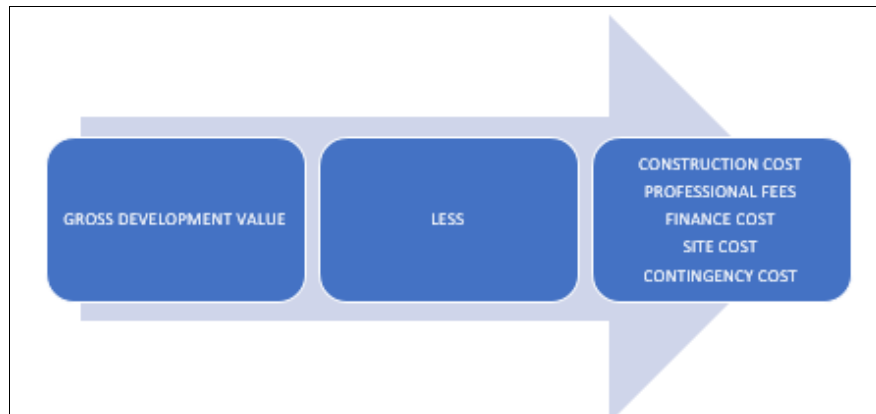
### **Disadvantages**

- 1) This software is costly to purchase.
- 2) Technical knowledge is required to run this software.

### **Assessment of Risk for Development Cost in the Process of Decision Making**

The appraisal preparation for the development cost in the green project is crucial for the developer or clients. Therefore, during this stage, assessing risk on the development cost is fundamental. The incurred cost on the construction, finance, site, and all fees for the professional team and contingency must be evaluated deeply by the developer. The client and team should determine the risk of overestimating or underestimating at the appraisal stage (B., 2014). Estimating the final cost of projects is extremely difficult due to factors such as type of project, material costs, design, duration, size of the project and tendering method (Ahiaga Dagbui & Smith, 2014). Therefore, assessment of risk for the cost in the development project is fundamental. The impact on the construction delay is if the quantity surveyor calculates an insufficient budget. Sayce (2015) explained that the methods that are most frequently used to assist decision-making during the preparation of investment appraisal are as follows:

- 1) Comparability
- 2) Residual Valuation
- 3) Discounted Cashflow
- 4) Cost-benefit analysis
- 5) Others.



**Figure 2:** Shows gross development value less with overhead for the development project.

The equations used for the calculation are presented below;

$$NPV = \sum_{t=0}^n \frac{CF_t}{(1+i)^t}$$

Here;

CF<sub>t</sub> = Expected return from the investment in the t period, the probability-weighted average

PV = Present Value of all expected returns over the n-year life of the investment

i = the appropriate rate of discount for future returns

Several detailed discounted cashflow approaches can be adopted in the construction industry. Yet, all are based upon a much more extensive pre-assessment of the cost estimate that is prepared by the quantity surveyor. Therefore, the Tornado simulation analysis will be based on the project itself as a case study. The discounted cash flow approach has several general advantages:

- 1) Finance costs can be accurately computed.
- 2) The timing of inflow and outflow can be accurately represented, and they can be adjusted periodically by period to test the sensitivity of overall returns to such changes.
- 3) Variations in costs and prices can be built into the model.
- 4) The time structure of the problem, elements such as phasing, rental and selling can be included in the model.
- 5) More information becomes available to the decision-maker, improving the decision.

Equally, modelling based on these methods requires careful consideration of the actual structure of many variables, their values at the start of the development, their incidence throughout the development, and any changes that are thought possible. Risk assessment analysis was conducted using tornado analysis. The process of identifying risk for development cost is illustrated diagrammatically at the pre-contract stage in Figure 3.

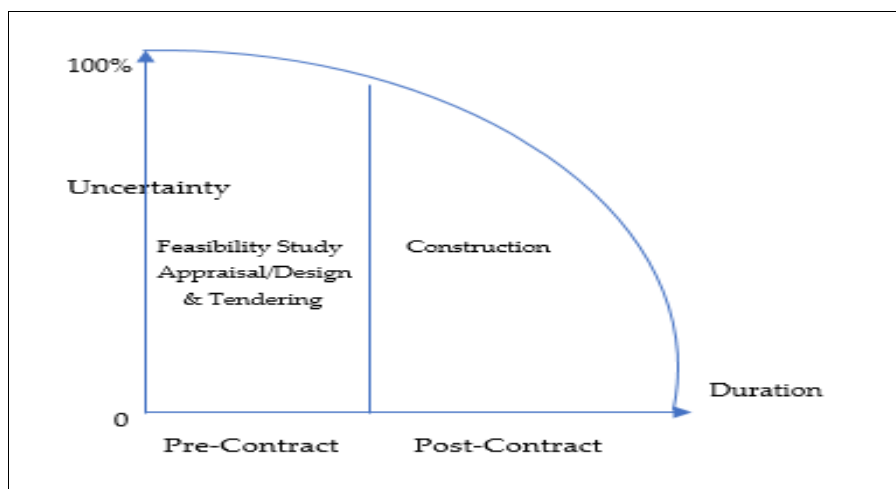


Figure 3: process of identifying risk for development cost is illustrated diagrammatically at the pre-contract stage

The financial risk assessment for green development costs was evaluated at the pre-contract stage. Using simulation, tornado analysis, the decision-maker has the experience to test data accurately before making a decision. A tornado analysis provides a graphical view of how the result is sensitive to the specified independent variables. The Tornado risk analysis function evaluates the impacts of risk prioritised during the qualitative risk analysis process and quantifies project risk exposure such as construction financial risks. This method shows the effects of the probability of occurrence and impact on the project objectives.

## RESEARCH METHODOLOGY

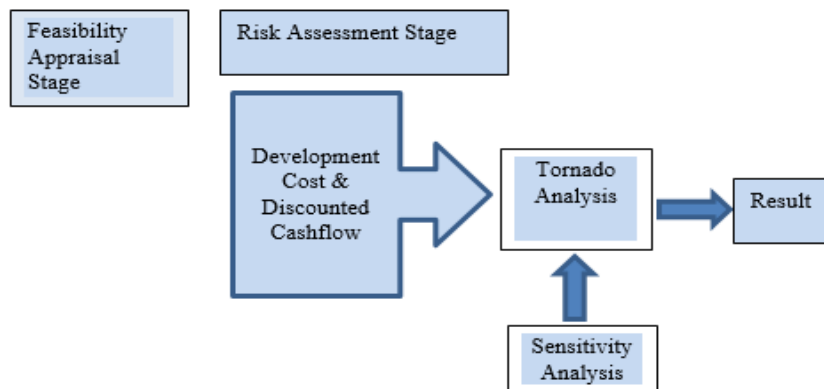
The research employed a qualitative method. Piaw (2012) has described qualitative research use, where numerical data produced cannot explain many types of phenomena in the real world. For case studies, the essential benefit of documents is to corroborate and augment evidence from other sources (Yin, 1994). There are exceptional cases that require more careful observation. Therefore, a selected case study of a green development project was analysed. The chosen project information is as follows:

**Propose a Green Development for a 7-Storey Hotel, 135 rooms, at Pulau Langkawi, Kedah, Malaysia.**

Some of the standard features of green buildings elements adopted for the 7-Storey Hotel are:

- 1) Energy Efficiency
- 2) Renewable Energy Generation
- 3) Water Efficiency
- 4) Stormwater Management
- 5) Natural Ventilation
- 6) Sustainable Material
- 7) Effective Waste Management
- 8) Site Sustainability

The researcher analysed the document analysis with information content on development cost and discounted cash flow. The analysis was carried out using a risk simulator software to perform the Tornado Analysis. Figure 4 shows the analysis process for Tornado.



**Figure 4:** Shows the analysis process of simulation techniques using Tornado

## RESULTS AND DISCUSSION

A sensitivity analysis was performed to identify the nature of the response to the development cost for a seven-storey hotel for green development. The analysis was performed for a development cost using a tornado application. The simulation was run for all exogenous variables across a reasonable range from the base conditions. A 10% increase and a 10% decrease were detected in Figure 4, the spider chart. The variable with a steeper line has more influence on the development cost.



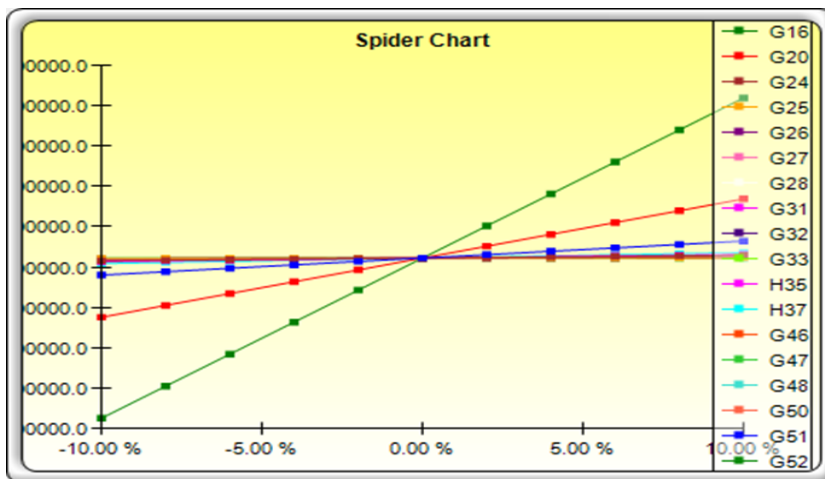


Figure 5: shows Spider Chart

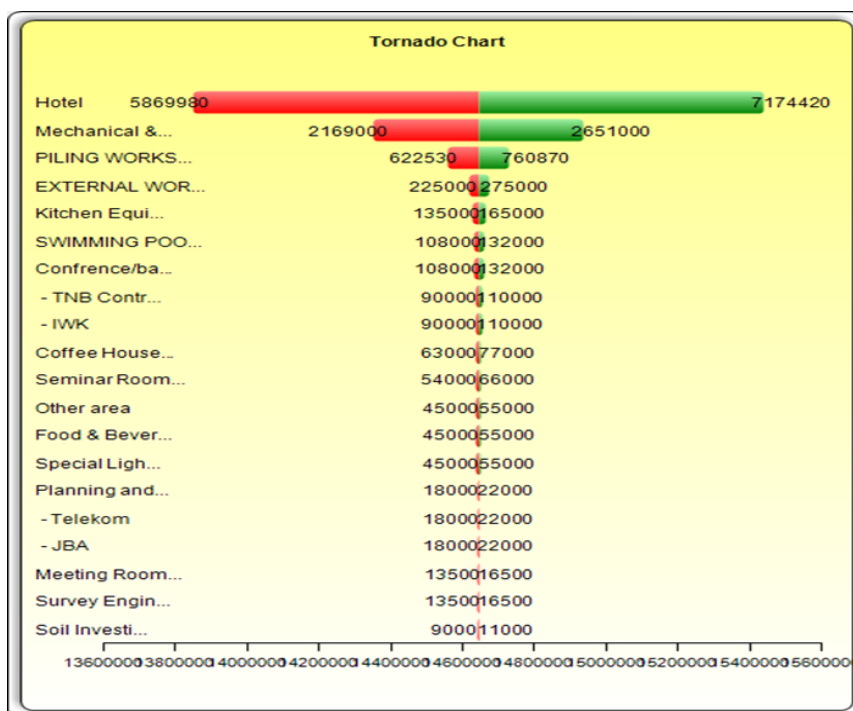


Figure 6: shows Tornado Chart

The resulting Figure 6 indicates the construction of green development for a 7-storey hotel. The tornado shows that a significant risk has appeared at the top of the graph. The top bar displayed the highest risk tabulated for a hotel which

is for the building cost. The bar colours indicate the direction of the relationship between the variable and the forecast. Forecast data will help the developer understand the most affected variable on the budget for the development cost (Atherton, French, & Gabrielli, 2008). The building cost to construct a 7-storey hotel is detected as the most sensitive element, followed by mechanical and electrical work and sub-structure work for piling. Also, the building cost is the most sensitive issue in green development because the material selected has to consider sustainability. The price of the material differs compared with conventional development. The increased cost of 10% of the material in the green building is due to low or non-toxic and minimal chemical use (Halil et al., 2020). The material selected is longer lasting and used in natural products. As confirmed by (Isaac, O'Leary, & Daley, 2010), the construction cost depends on the interplay between several related factors, including development size, site servicing and layout, quality of materials, type and design of a building, and the additional costs that attract higher capital costs. The second major element contributes to the higher cost of financial risk for the mechanical and electrical equipment. Materials and components for mechanical and electrical works meet the energy efficiency, and the cost to install in green buildings is very high. (Touny, Ibrahim, & Mohamad, 2021) were identified as critical success factors (CSFs); material and financial costs contribute to the successful implementation of sustainable development. Therefore, the client should provide a sufficient budget for green development. The developer themselves may play a substantial part in determining these estimates, particularly when they specialise in a particular type of development. Tornado analysis helps the client identify the risk for the cost of the elements that affect the construction of a hotel. Other piling works contribute to the third major risk for the construction of green hotel development. Piling construction is driven by using materials and heavy plants. Typically, concrete and steel piling is used as the primary materials in construction in Malaysia. The environmental impacts of piling construction can be broadly classified in terms of CO<sub>2</sub> emission (due to volume of material and energy consumption), soil contamination, noise, air quality and waste generation.

## **CONCLUSIONS**

Tornado analysis is a fundamental part of the development decision-making process. Essentially development will only proceed when the client has evaluated the financial risk. Profit motivation and sustainability are critical considerations for the developer. Sensitivity analysis is essential to assess how the input variables of a tornado model affect the output. Data can be acquired from the information that is received through sensitivity analysis; thus, more effective management decisions can be made. The research outcomes and tornado analysis provide a guideline for the quantity surveyor and client, namely,

on the crucial costs that impact the construction of a hotel in green development. The client knows which risks have the most extensive project impact and evaluates the risks before the project starts. The building cost (hotel), mechanical and electrical, and piling works are the most critical and pose the highest risk for the client in green development for the hotel. Design and materials that are used play a pivotal role in green development, and material selection has noticeable and significant implications for energy and greenhouse gas emissions (Huo et al., 2020).

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Received: 10<sup>th</sup> December 2021. Accepted: 12<sup>th</sup> April 2022