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Selection factors of procurement method for steel building in Sarawak

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ABSTRACT

The selection of procurement methods is usually suggested based on cost, quality, and time considerations. Previous studies have shown that ineffective procurement methods often lead to project budget overruns, delays, or disputes. However, there have been limited studies on the selection factors of procurement methods for steel building. The increasing popularity of steel building construction is significant due to its versatile design and easy installation, which result in time and cost savings. Thus, this study aims to investigate the factors influencing the selection of procurement methods for steel building in Sarawak. Online questionnaire surveys were distributed to the engineers, contractors, and quantity surveyors with experience in steel building construction, yielding 121 valid responses. Descriptive statistics were employed to analyse the data. The findings reveal that price competition and project complexity are the two most significant factors in the procurement of steel buildings. This study could assist stakeholders involved in steel building construction in identifying critical factors for selecting the most appropriate procurement methods, thereby ensuring effectiveness in terms of cost and time, while also reducing the chances of disputes.

1.0 INTRODUCTION

Steel building construction involves off-site fabrication, which is then transported and installed at the construction site (Chen et al., 2020). Prefabricated steel building construction comparatively can significantly reduce construction time by approximately 40% compared to traditional methods (Navaratnam et al., 2019). The growth of the construction industry and an increase in infrastructure projects have heightened the global demand for steel buildings. These projects often emphasize the need for time and cost savings as well as installation flexibility (Imarc Group, 2021). It is predicted that the global

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prefabricated buildings market size will experience a Compound Annual Growth Rate (CAGR) of 5.75% by 2025 (Mehra, 2020). North America is the largest market for prefabricated steel buildings globally, followed by the Asia Pacific (Business Wire, 2021). In Malaysia, an annual growth rate of 6.2% until 2026 is expected to occur in the construction industry, driven by energy-related projects and large-scale transport initiatives (Business Wire, 2022). Additionally, the concept of prefabricated construction is supported by its ability to reduce waste and promote green building practices in different sectors such as residential and commercial (Iacovidou et al., 2021).

The efficiency of the steel building construction undoubtedly affected by the procurement methods chosen, which are characterized by their impact on time, cost, and quality (Ramasamy et al., 2016). The construction process experienced various issues due to a lack of communication, fluctuating client expectations, and economic downturn, resulting in detrimental outcomes including project delays, increased costs, and conflicts. Various procurement methods like management contracting and design-build have been suggested to mitigate these issues (Chamal et al., 2013; Naoum & Egbu, 2016). Effective procurement method selection could reduce conflicts and disputes (Senarath & Mathusha, 2021).

However, there is a relative lack of studies focusing on the selection factors for procurement methods in steel building construction, especially compared to the other construction procurement types. For instance, Malaysian construction projects' procurement methods selection (Yap et al., 2019), Gaza Strip's procurement methods selection based on multi-attribute utility theory (Sawalhi & Agha, 2017), and procurement methods selection for steel buildings in Nigeria (Perera et al., 2019). A lack of study on the factors of procurement methods selection for steel building in Malaysia is crucial as Malaysia, a developing country, is experiencing a rise in steel building construction that ranks 26th as an exporter and 39th as an importer of steel worldwide (Observatory of Economic Complexity, 2020). One of the largest cities in Sarawak, Miri, has experienced the highest increased in the building material cost index (BCI) on single storey steel frame (Department of Statistics Malaysia, 2022). Hence, the construction stakeholders shall not overlook the most appropriate procurement method for construction materials. Shehu et al. (2014) argued that effective procurement could reduce project cost overruns, citing a 20% cost savings in design-build methods compared to traditional approaches. This underscores the need to examine the factors affecting the selection of procurement methods for steel buildings in Sarawak to ensure project success in terms of quality, time, and cost. Therefore, this study aims to identify the selection factors of steel building construction from the perspectives of construction stakeholders in Sarawak.

2.0 LITERATURE REVIEW

Studies related to procurement methods have been conducted on various factors and framework. For instance, Ghadamsi and Braimah (2012) proposed a conceptual framework that covers both traditional and design-and-build methods, focusing on procurement selection factors. In Gaza Strip, Sawalhi and Agha (2017) developed a framework for selecting the most suitable procurement technique and stressed on the importance of price competition.

Internationally, countries such as the United Kingdom, Nigeria, and South Africa have investigated different procurement methods in the construction industry (Agapiou, 2020; Perera et al., 2021; Yap et al., 2019). In South Africa, procurement method selection was reported to be affected by the procurement policy set by the government (Thwala & Mathonsi, 2012). Ojo and Gbadebo (2012) identified project complexity as the most important factor for Nigeria. In Sri Lanka, the speed of construction for steel buildings was recognized as the most crucial factor (Perera et al., 2019). In Pakistan, Bhutto et al. (2019) discovered that the financial capability of clients and achieving project completion within estimated time and cost are significant factors. In the Gaza Strip and Enugu State, Osama (2013) and Akudoro et al. (2021) highlighted price competition, project complexity, and time constraints as the prominent factors affecting

procurement method selection from the viewpoint of construction stakeholders. These studies seem to imply that factors identified as important vary based on geographical location. Moreover, the government policy and the practices of construction professionals can influence procurement method selection (Sawalhi & Agha, 2017).

In Malaysia, Othman et al. (2015) suggested that the procurement process coordination significantly affected by the marketing resources. Yap et al. (2019) conducted a study with consultant quantity surveyors and identified price certainty as the most critical factor affecting construction procurement method selection. Suratkon et al. (2020) compared the characteristics of different procurement methods. Little to none of the studies explicitly focus on the steel building construction in Sarawak. Table 1 shows the list of the factors identified from the literature.

Table 1. List of factors identified from literature

Categories	Factors	References	
Client-related	Qualified professional involvement	Sawalhi and Agha (2017), Agapiou (2020), Thwala and Mathonsi (2012), Perera et al. (2019) Akudoro et al. (2021), Osama (2013), Agapiou (2020), Perera et al. (2019)	
	Client's needs		
	The degree of desired client involvement		
	Client's financial capability		
	Flexibility for changes and variations		
	Client's experience		
Cost-related	Client reputation	Akudoro et al. (2021), Osama (2013)	
	Client's nature and culture		
	Cost control		Akudoro et al. (2021), Osama (2013), Agapiou (2020)
	Certainty of price		
	Funding method		
	Price competition		
Consultant fees	Akudoro et al. (2021), Osama (2013)		
Design cost			
Time-related	Time certainty	Naoum and Egbu (2016), Ghadamsi and Braimah (2012) Akudoro et al. (2021), Osama (2013)	
	Construction speed		
	Time control		
	Delivery schedule		
	Design time		
Risk-related	Time constraints	Agapiou (2020), Ghadamsi and Braimah (2012), Ojo and Gbadebo (2012)	
	Site risk		
	Risk avoidance and allocation		
	Disputes and arbitration		
	Allocation of responsibility		
Project characteristic s-related	Controllable variation	Akudoro et al. (2021), Osama (2013), Agapiou (2020)	
	Constructability of project design		
	Material availability		
	Available resources of project		
	Project size		Agapiou (2020), Perera et al. (2019)
	Project site location		
	Material transportation process		
	Quality level of project		Akudoro et al. (2021), Osama (2013)
	Construction method		
	Availability of procurement system in the local market		
	Project methodology		
	Project type and nature		
Project objective	Bolumole (2017), Bako (2016)		
Complexity of project		Akudoro et al. (2021), Osama (2013), Bako (2016)	

External environment-related	Stakeholder integration	Akudoro et al. (2021), Osama (2013), Bhutto et al. (2019)
	Procurement policy	
	Environment impact	
	Social factors	Akudoro et al. (2021), Osama (2013), Perera et al. (2019)
	Economic conditions	
	Market structure	
Political considerations		
Technology performance		

3.0 RESEARCH METHODOLOGY

This study adopted a quantitative method to investigate the factors affecting procurement method selection for construction materials of steel building. The nature of this study which focuses on steel building construction is an area has been receiving little attention, indicating towards the suitability of an explorative approach. However, this study adopted quantitative approach to confirm the factors derived from the literature review (see Table 1). Moreover, a questionnaire survey could reach a large group of respondents while also achieving time and cost efficiency (Vasanth & Harinarayana, 2016). The questionnaire was designed to collect respondents' demographic details and for respondents to rate their level of agreement with various selection criteria for steel building procurement methods on a five-point Likert scale (i.e. 1: strongly disagree, 2: disagree, 3: neither agree nor disagree, 4: agree, and 5: strongly agree)

The questionnaires were distributed to engineers, contractors, and quantity surveyors through email and door-to-door visitation approaches from October to December 2022. These groups were selected because they are involved in the procurement of construction materials in relation to steel buildings. Moreover, the engineers and quantity surveyors are involving in the selection of procurement method of construction project (Sawalhi & Agha, 2017). Wondimu et al. (2020) suggested that early involvement of contractors in the procurement process could enhance the project efficiency. A simple random sampling method was employed in this study. As of September 2022, there were 967 building contractors, 11,414 engineers, and 566 quantity surveyors registered under the Construction Industry Development Board, the Board of Engineers Malaysia, and the Board of Quantity Surveyors Malaysia respectively (Board of Engineers Malaysia, 2022; Board of Quantity Surveyors Malaysia, 2022; Construction Industry Development Board Malaysia, 2022). As such, the total population amounted to 12,947. As of the basis of Slovin's formula, the sample size of this study was 389.

A total of 389 questionnaires were distributed, yielding 131 returned responses. As the respondents needed to have experience in handling steel building projects to ensure research reliability, hence, respondents indicating a lack of such experience were excluded from the data analysis and were not counted as valid responses. Additionally, responses with high consistency (i.e., selecting the same option for all Likert-scale questions) were also eliminated from the analysis. This led to ten responses being removed from the count of valid responses, yielding 121 valid responses and a response rate of 31%. Descriptive statistics were used to analyse the data collected. The Cronbach's Alpha method was used to ensure internal consistency and validity of the findings.

4.0 FINDING AND DISCUSSION

4.1 Demographic details

Table 2 shows the background of respondents (refer to Table 2). The respondents come from fairly evenly distributed backgrounds, including engineers (36.4%), contractors (32.2%), and quantity surveyors (31.4%), who are based in major cities across Sarawak. The majority of respondents (66.9%) possessed experience with more than five steel building projects. This suggests that the respondents possess hands-on experience with steel building construction and can offer opinions based on their experiences. The steel

building projects that had been handled by the respondents were based on traditional and design and build procurement methods. Moreover, all respondents agreed that the procurement method selection impacted the quality of steel building construction.

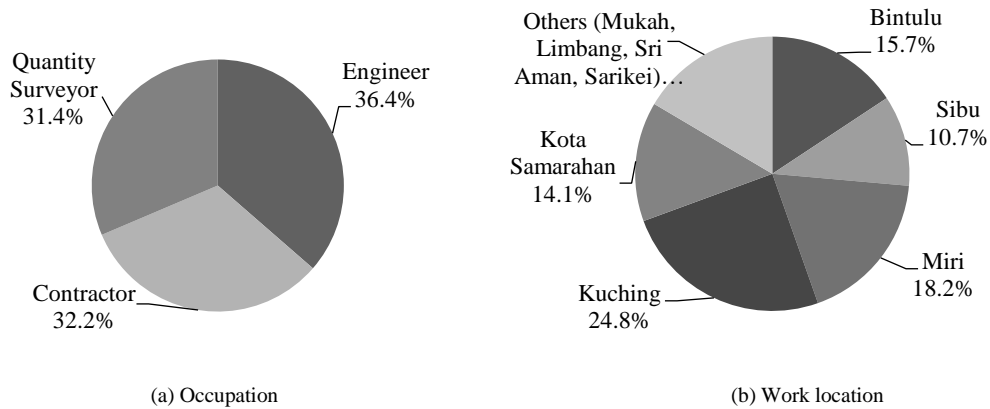


Fig. 1. Background of respondents

4.2 Selection factors of procurement method

Six categories of procurement factors were identified: project characteristics-related, cost-related, risk-related, client-related, time-related, and external environment-related factors, which followed the categorisation of Osama (2013). The analysis of all factors yielded a Cronbach's Alpha value of 0.9, indicating a high level of research reliability. Table 3 shows the factors affecting the selection of procurement methods for steel buildings, along with the means, standard deviation (SD), and ranking.

Table 2. Mean, standard deviation, and ranking of the factors affecting selection of procurement method

Factors	Mean	SD	Rank
Client-related factors:			
Qualified professional involvement	4.628	0.607	3
Client's needs	4.025	0.701	4
Client's financial capability	4.661	0.571	2
Flexibility for changes and variations	3.438	0.875	6
The degree of desired client involvement	3.719	0.536	5
Client reputation	3.380	0.897	7
Client's experience	4.736	0.529	1
Client's nature and culture	2.397	1.594	8
Cost-related factors:			
Cost control	2.826	0.587	5
Certainty of price	4.025	0.724	2
Funding method	3.240	0.671	4
Consultant fees	2.091	0.894	6
Design cost	3.256	0.571	3
Price competition	4.876	0.331	1
Time-related factors:			
Delivery schedule	1.562	0.706	6
Design time	3.645	0.884	2
Time certainty	2.430	1.102	5
Time control	2.760	0.500	4
Construction speed	3.339	0.737	3
Time constraints	4.760	0.429	1

Risk-related factors:			
Site risk	1.240	0.429	5
Risk avoidance and allocation	4.496	0.607	1
Disputes and arbitration	3.000	0.816	3
Allocation of responsibility	4.231	0.655	2
Controllable variation	2.174	1.327	4
Project characteristics-related factors:			
Constructability of project design	3.736	0.783	6
Material availability	1.198	0.459	13
Material transportation process	1.959	1.350	10
Level of quality for a project	3.967	0.795	5
Construction method	2.000	0.408	9
Local market's procurement system availability	4.322	0.698	4
Available resources of project	2.950	0.405	7
Project methodology	1.653	0.478	12
Project size	4.686	0.592	2
Project site location	1.835	0.415	11
Project objective	2.835	0.435	8
Project type and nature	4.587	0.601	3
Complexity of project	4.785	0.451	1
External environment-related factors:			
Stakeholder integration	1.182	0.500	6
Technology performance	1.884	0.635	5
Environment impact	1.099	0.327	7
Social factors	1.025	0.203	8
Economic conditions	2.099	0.597	4
Market structure	2.314	0.775	3
Political considerations	2.628	0.534	2
Procurement policy	4.322	0.733	1

Client-related Factors

“Client’s experience” had the highest mean value of 4.736 under the client-related factors category. This finding tallies with Osama’s (2013), who emphasized the importance of experienced clients in risk management. Since the client has the power to decide the type of procurement method to be selected, their choice could significantly influence the project’s success. This decision may be based on the client’s past experiences (Sawalhi & Agha, 2017). In contrast, inexperienced clients may require professional advice to select the procurement method (Bhutto et al., 2019). Clients should consider this decision carefully; if it is made based on conservative advice from consultants or past experiences, there is a risk of negative outcomes (Agapiou, 2020). This consideration leads to the third ranked factor of “Qualified Professional Involvement”. Professional involvement is essential for establishing an effective procurement method, especially off-site construction (Agapiou, 2020).

“Client’s financial capability” was ranked as the second highest factor. This factor impacts steel building construction, affecting time, cost, and quality, including cash flow. Umeokafor (2017) supported that construction professionals must identify their clients’ financial capability during the tender evaluation stage. Moreover, the project tender bidding shall be ceased if the client’s financial condition appears inadequate for completing the project (Perera et al., 2019). This suggests that clients need to have a certain level of skill and knowledge in managing their finances to meet the project’s requirements (Thwala & Mathonsi, 2012).

Cost-related Factors

The results showed that “price competition” which is one of the cost-related factors, had the highest mean value of 4.876 among all the factors. The average price of a mild steel round bar unit and high tensile

deformed bar unit increased by 6.3% and 13.2% respectively from 2021 to 2022 (Department of Statistics Malaysia, 2022). This trend appears to place a greater burden on stakeholders involved in steel building construction, as they must adhere to the prices stated in tender documents. Naoum and Egbu (2016) emphasised the vitality of price competition during the tender stage as a factor influencing procurement method selection. Moreover, price competition undeniably contributes towards procurement of construction materials due to economic conditions (Osama, 2013).

“Certainty of price” and “design cost” were ranked as the second and third most important factors in this category, respectively. Clients could determine the need to consider design costs and the timing between setting initial cost targets and analysing tenders (Jimoh et al., 2016). Akudoro et al. (2021) confirmed that the level of design completeness can impact tender prices. Hence, it is crucial to complete the design before the project begins to prevent design changes for achieving price certainty and ascertaining of project resources (Jimoh et al., 2016; Yap et al., 2019). Such measures could enable clients to effectively manage resources, such as cash flow, in the project’s early stages (Yap et al., 2019).

Time-related Factors

“Time constraints” was ranked as the most important factor in the category of time-related factors. The primary objective of any project is to meet budget expectations within the specified timeframe while maintaining quality. Therefore, time is of the essence, especially for projects with shorter time frames, such as steel building construction, to prevent cost overruns (Bako, 2016; Bolumole, 2017). However, natural disasters like extreme weather conditions can introduce additional risks, leading to time constraints (Tayeh et al., 2020). The second most important factor, “design time,” significantly influences the project timeline. This is important to prevent cost overruns issue especially for shorter timeframe projects (Bako, 2016; Bolumole, 2017). This influences the selection of procurement method of construction materials to assist with project completion timeline (Yap et al., 2019).

“Construction speed” was ranked as the third most important factor, a finding that aligns with Perera et al. (2021) in the context of Sri Lankan steel building projects. To increase construction speed, technological and labour investment shall not be overlooked (Windapo et al., 2021). However, studies argued that speedy construction often leads to higher costs, creating the issue of cost overruns (Umeokafor, 2017).

Risk-related Factors

“Risk avoidance and allocation” was ranked as the most crucial factor in the risk-related factors category. This underscores the importance of considering risk during the procurement stage to minimize the likelihood of disputes, time, and cost overruns. This indicates the importance of considering the factor of “disputes and arbitration,” which ranked third in this category. Therefore, contracts should clearly specify which party is responsible for potential risks, enabling that party to manage and mitigate those risks effectively (Umeokafor, 2017). In line with this, the finding of “allocation of responsibility” emerged as the second most important factor. Perera et al. (2019) emphasized the differences in risk allocation among different procurement methods. Different parties are responsible for potential events within a construction project that could significantly impact the project’s completion (Osama, 2013). Hence, it is essential to carefully select a procurement method in order to mitigate certain foreseeable risks (Bako, 2016).

Project Characteristics-related Factors

The “complexity of project” was ranked as the most important factor in the project characteristics-related factors. This finding is in line with Akudoro et al. (2021) and Osama (2013), who stressed the significance of project complexity in a client’s decision-making for procurement method selection. Moreover, the project complexity could be affected by “project size” and “project type and nature,” which ranked as the second and third most important factors. This corroborates findings from Bako (2016), who also pointed out other factors affecting project complexity, such as construction methods. Hence, it is vital

to consider the project complexity level when selecting a procurement method (Bhutto et al., 2019). Bakhski et al. (2015) stated that managing a complex project is challenging. Still, the project goal is achievable by analysing early indicators of success and failure and concentrating on the project's complexities.

External Environment-related Factors

In terms of external environment-related factors, "procurement policy" was ranked at the first place. The procurement policy determines the ways that a project shall be carried out. Furthermore, cost and speed serve as criteria for selecting a procurement policy (Osama, 2013). Bhutto et al. (2019) emphasized the significant impact of the Pakistan Public Procurement Regulatory Authority (PPRA) on procurement policy. This is corroborated by Hassan et al. (2021), who noted that Malaysian public procurement policy aids in the effective allocation of budgets. The Ministry of Finance in Malaysia further assists with the government procurement processes (Baker McKenzie, 2022). Consequently, it is evident that "political considerations" could influence the choice of procurement method. Perera et al. (2019) and Windapo et al. (2021) affirmed that political factors could impact a client's business and the procurement method selection.

To sum up, the most important factor is "price competition" under the "cost-related factors" followed by "complexity of project" under the "project characteristics-related factors" and "construction speed" under the "time-related factors". This seems to imply that the financial aspect, complexity of project and the time are the top three most crucial factors to be considered for steel building construction. With a large number of the factors exist in the procurement methods' selection, the stakeholders may be focusing on these three factors to ensure more efficient and effective process for steel building construction.

5.0 CONCLUSION

This study identified "price competition" emerging as the most influential factor in selecting a procurement method. Sarawak is located in East Malaysia, and majority of the construction materials are shipping from Peninsular Malaysia, leading to a surge in the price of construction materials. Hence, proper considerations on the procurement methods that could possibly affecting the cost, complexity of project and time are essential. The increment on the unit price of steel from year-to-year are affecting the price competition. The findings of this study may apply to stakeholders involved in steel building construction in Sarawak, highlighting key factors to consider when selecting a procurement method for construction materials, especially concerning price. This could potentially reduce the dispute occurrences, cost overruns, and request for extension of time, specifically in the midst of inflation on construction materials. Moreover, the construction stakeholders could focus their resources on the time, cost and project-related factors when selecting the most appropriate type of procurement methods for steel building construction, to allow more effective resource allocations. Since this research targeted only engineers, contractors, and quantity surveyors, future studies could explore the government's perspective for more effective procurement policy planning, especially in achieving one of the thrusts in National Construction Policy 2030 to improve the construction productivity.

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8.0 CONFLICT OF INTEREST STATEMENT

The authors agree that this research was conducted in the absence of any self-benefits, commercial or financial conflicts and declare the absence of conflicting interests with the funders.

9.0 CONTRIBUTION OF AUTHORS

The authors confirm the equal contribution in each part of this work. All authors reviewed and approved the final version of this work.

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