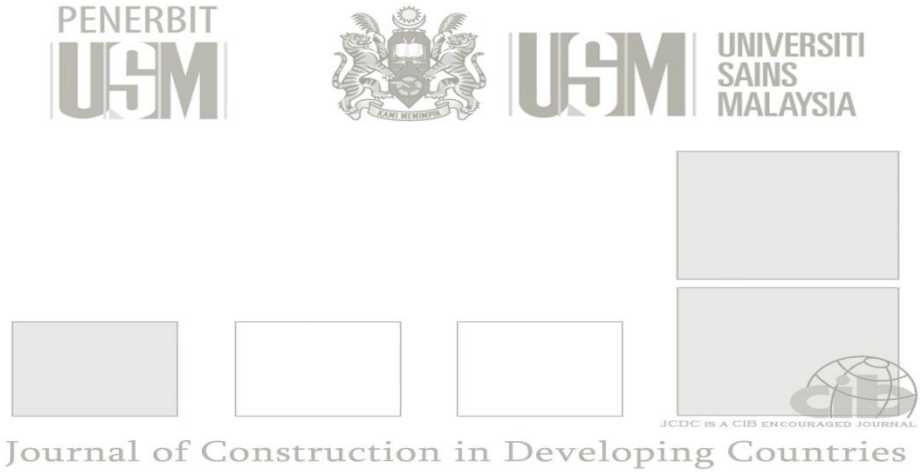

Manuscript Title	Critical Factors Influencing the Performance of Public Housing Construction Projects in Myanmar
Authors	Kriengsak Panuwatwanich, Su Su Nwal and Myint Naing
Submitted Date	27-Feb-2023 (1st Submission)
Accepted Date	11-Aug-2023
DOI	https://doi.org/10.21315/jcdc-02-23-0022

CRITICAL FACTORS INFLUENCING THE PERFORMANCE OF PUBLIC HOUSING CONSTRUCTION PROJECTS IN MYANMAR

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ABSTRACT

Public housing is a basic need for low- and middle-income families. Unfortunately, in many developing countries, housing construction projects often fall short of achieving required performance levels. This problem occurs for many reasons: low budget, corruption, poor governance, inadequate policy and the lack of modern technologies used in construction. As a developing country, Myanmar has faced these challenges in public housing construction projects. Although many studies have investigated the factors influencing the performance of construction projects, there has been limited examination of research specifically focused on public housing construction, particularly in the context of Myanmar. Myanmar planned to provide one million homes by 2030. However, the country has faced significant challenges, including political instability and the COVID-19 pandemic. Therefore, this study identifies the critical factors influencing the performance of public housing construction projects in Myanmar (PHCPM) amid the current changing circumstances. A survey was conducted to collect data from 86 experienced personnel on 51 factors identified in the literature review. The dataset was then analysed using a one-way analysis of variance (ANOVA) and frequency-adjusted important index (FAII) analysis method. The factors were ranked according to FAII scores, and 10 critical factors were identified and discussed. Based on the results, this study can help inform the individuals responsible for taking action to mitigate the impact of the critical factors identified for improving the performance of PHCPM.

Keywords: critical factors, construction performance, public housing, Myanmar, developing countries.

INTRODUCTION

Ensuring access to fundamental human needs, such as food, clothing, and shelter, is critical for human beings. In this regard, public housing serves as a primary means of affording safe and reasonably priced dwellings to those facing financial hardships. Generally, the type of housing provided by the government is called 'public housing', whereas those provided by state or non-profit organisations are called 'social housing' (McCarty, 2014). In Myanmar, housing provided by the government to low-income families, middle-income families and government staff can be categorised as low-cost housing, affordable housing and government staff rental housing, respectively. In the present paper, the term 'public housing' will be used to cover all types of housing provided by the government in Myanmar.

In 2015, the United Nations (UN) adopted Sustainable Development Goals (SDGs) as a universal call to action with the aim of enhancing people's enjoyment, peace and prosperity. The UN set 17 SDG goals. Goal 11 is to 'Make cities and human settlements inclusive, safe, resilient and sustainable' (UN, 2015, p. 24). According to this goal, people should have access to adequate, safe and affordable housing. Therefore, the iron triangle of 'time', 'quality' and 'cost' is the most important performance aspect for public housing construction projects to provide adequate, safe and affordable housing.

Across the world, national and regional governments have been attempting to provide dwellings for people in need (Habitat for Humanity, 2023). Nonetheless, housing construction projects are underperforming in many countries, for example, delays in Ghana (Amoatey et al., 2015) and Hong Kong (Li et al., 2018), cost overruns in Small Island Developing States (Chadee et al., 2022), and inferior quality in Hong Kong (Tam et al., 2011), Nigeria (Jiboye, 2011) and Malaysia (Hashim et al., 2012). Particularly in developing countries, where there is a lack of resources, expertise and budgets, public housing projects face underperformance problems.

In Myanmar, the trend of internal migration to urban areas has been increasing, resulting in a growing need for affordable housing for low-income individuals. It is estimated that Yangon, the commercial city of Myanmar, alone will require 1.3 million housing units by 2030 (Asian Development Bank [ADB], 2019). To fulfil the housing needs, the Myanmar government planned to provide one million housing units by 2030 (Rhoads et al., 2020). However, the country underwent political instability and the COVID-19 pandemic. Therefore, there is a need to study the challenges of undertaking large-scale housing construction projects in the face of changing circumstances in Myanmar.

To improve the performance of a construction project, it is important to understand the factors influencing its underperformance. By understanding these factors, practitioners can gain insights into the conditions causing the issues and develop strategies to address them. Therefore, many research studies have been conducted worldwide to identify the critical factors

influencing construction projects in terms of time, cost or quality, which are the three basic performance aspects primarily used for measuring project success (i.e., the iron triangle). Most existing studies have focused on one or two performance aspects of construction projects, such as delays (Amoatey et al., 2015; Chen et al., 2023; Dick-Sagoe et al., 2023) and cost overruns (Chadee et al., 2022; Sinesilassie et al., 2018).

There are limited studies focusing on public housing construction projects, which have unique characteristics. The budgetary constraints, high collaboration between the public and private sectors and strict rules and regulations often distinguish them from other types of construction projects. In addition, there is only a limited amount of research on public housing in Myanmar focusing on the policy level (Naing et al., 2021; Nwal and Panuwatwanich, 2018), history of housing provision (Naing, 2021) and delivery system (Nyein and Hadikusumo, 2021).

To address the aforementioned research gaps, the present study aims to recommend strategies for improving the performance of public housing construction projects in Myanmar (PHCPM). It has two objectives: 1) to identify the critical factors that influence PHCPM performance through an empirical study and 2) to provide recommendations for possible strategies that can enhance performance. By accomplishing these objectives, the current research offers a systematic and evidence-based understanding of these key factors, recommending possible strategies to the responsible individuals. In addition, the present study addresses the lack of research in the context of public housing construction projects in developing countries, particularly Myanmar, and can guide future research endeavours in this field.

The current paper includes six sections. The introduction, Section 1, is followed by the literature review in Section 2, which discusses the investigation into the key players and issues of Myanmar's public housing construction. Moreover, the potential factors that may influence construction performance are reviewed. Section 3 presents the methodology and analysis tools. Section 4 explains the data analysis. Finally, Section 5 presents the results and discusses the findings, which leads to the conclusion in Section 6.

LITERATURE REVIEW

Key Players of Public Housing Construction Projects in Myanmar

By 2030, the Myanmar government plans to construct one million housing units to address housing shortages and the increasing demand for housing (ADB, 2019). Of these planned units, 20% will be constructed by the Department of Urban and Housing Development (DUHD), while the government and private sector will construct the rest (80%) (ADB, 2019). As a result, public housing construction has dramatically increased since 2011.

Apart from DUHD, local government departments, such as the Yangon City Development Committee (YCDC) and the Mandalay City Development Committee (MCDC), also provide public housing. Construction is carried out by DUHD's standard designs, while local government departments, such as the YCDC and MCDC, are responsible for building permits (Japan International Cooperation Agency [JICA], 2018).

In providing public housing construction, the DUHD plays the role of both designer and client because public housing buildings are constructed according to the DUHD's standard design. Third-party consultants review the progress and quality of construction carried out by contractors. They monitor construction progress and quality to verify that the project fulfils specifications. Based on the progress of the construction, the consultant certified approval upon completion of the work. After obtaining the consultant's approval, contractors can take their payment from the client (JICA, 2018).

Issues of Public Housing Construction Projects in Myanmar

According to the Housing Census report, Myanmar's population was 51 million in 2014, and substandard housing, such as housing with bamboo walls, accounted for 51.2% of the total housing across the country (Department of Population [DoP], 2015). Therefore, it is important to promptly address the immediate housing needs of the most disadvantaged individuals living in substandard conditions (DoP, 2017).

However, the progress of public housing construction by Myanmar government has significantly fallen behind demand, leaving many individuals unable to afford the available units (Rhoads et al., 2020). In addition, in 2017, the JICA survey group conducted on-site surveys concerning the state of the quality control of housing buildings in Yangon (where most public housing units were constructed). According to the results, it was found that some public housing buildings had poor concrete finishing, the precision of the formworks was low, and the work was not well finished overall (JICA, 2018). In addition, according to a report by the ADB in 2019, the climate resilience design for low- and middle-cost housing that can resist cyclones and earthquakes, to which Myanmar is prone, needs to be considered (ADB, 2019).

Meanwhile, bank loans were too high for contractors, with a 13% interest rate (ADB, 2019), whereas the contractor received only 3% of the construction costs for construction management. This is a major problem for contractors because they are unable to access the needed capital to complete the project on time (Nyein and Hadikusumo, 2021). As a result, they are forced to either delay the project, which leads to further financial strain, or take out high-interest loans to cover the costs. Additionally, the current political climate and rising inflation rates (at the time of writing this paper) have contributed to further issues affecting the timely and cost-effective completion of PHCPM projects.

Currently, Myanmar can only provide just over 100,000 housing units during the period of 1990–2011 (51,649 units from 1990–2010 and 50,600 units from 2011–2021) (Naing, 2021). In contrast, other Southeast Asian countries have been able to provide a greater number of housing units. Singapore, for example, has constructed one million housing units as of 2023, according to the Housing and Development Board (HDB, 2023). Furthermore, in Thailand, the 'Bann Eua-Arthorm' programme alone was able to produce about 600,000 housing units in 2010 (National Housing Authority [NHA], 2023).

Although Myanmar is still using traditional methods for public housing construction, in Southeast Asia, countries such as Thailand and Singapore have adopted different construction approaches (HDB, 2023). The specific methods employed depend on each country's socio-economic context. To improve the efficiency, quality and sustainability, innovative techniques such as prefabrication, precast construction, modular construction and digital technology integration have been practiced worldwide, including in Southeast Asia (Latiffi et al., 2015; Mandala and Nayaka, 2023). These methods aim to streamline processes, reduce costs and ensure the provision of affordable and high-quality housing to their respective populations (Thai et al., 2020).

Factors Influencing the Performance of Construction Projects

A critical literature review has been conducted to compile a list of the factors influencing the performance of construction projects. The factors were selected based on the most relevant research publications, including the research on public housing construction projects, public construction projects, large construction projects and other infrastructure construction projects. In addition, because of limited publications in the context of Myanmar, the literature review covered a wide range of publications, including many countries such as Malaysia (Hashim et al., 2012; Sambasivan and Soon, 2007), Vietnam (Le-Hoai et al., 2008; Luu et al., 2009), Taiwan (Cheng et al., 2011), Ethiopia (Sinesilassie et al., 2018), Jordan (Sweis et al., 2014), Nigeria (Akanni et al., 2019) and Saudi Arabia (Assaf and Al-Hejji, 2006). A total of seven groups of factors influencing the performance of construction projects were categorised: 1) external factors, 2) client-related factors, 3) contractor-related factors, 4) consultant-related factors, 5) supplier-related factors, 6) subcontractor-related factors and 7) other factors during the construction process. A total of 51 factors, which have been grouped into seven categories, are summarised in Figure 1.

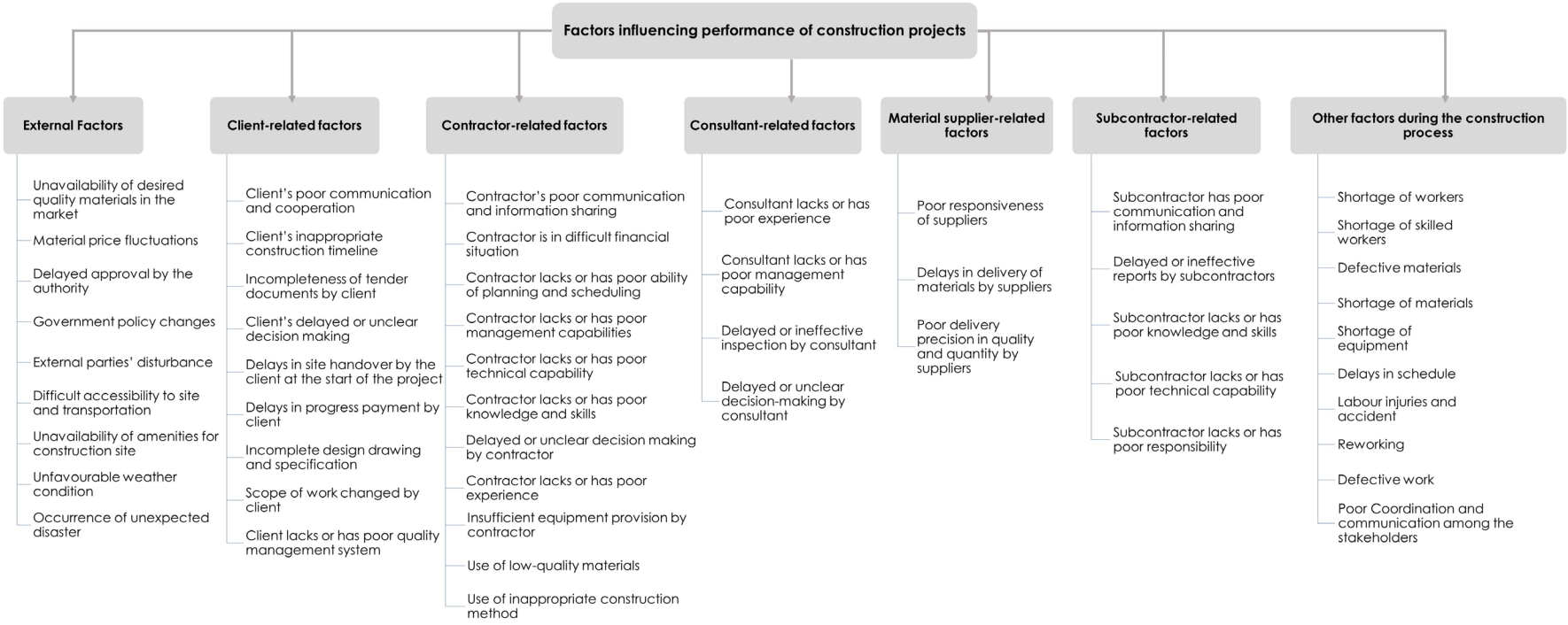

Figure 1. Factors influencing the performance of construction projects

The seven categories of influencing factors, along with the corresponding references, are presented in Tables 1 to 7, with detailed explanations provided below.

External factors

In the literature, external factors are frequently mentioned as factors that directly or indirectly affect construction projects' time, cost and quality. Aragonés-Beltrán et al. (2017) claimed that external factors do not lie within the network of the project. In other words, they are not under the control of the project parties, for example, the authority's permission, market conditions, the country's economy, weather conditions and external parties' disturbance (Alzahrani and Emsley, 2013; Chileshe and Boadua Yirenkyi-Fianko, 2012; Enshassi et al., 2009; Hatmoko and Khasania, 2016; Khodeir and Mohamed, 2015; Larsen et al., 2016; Luu et al., 2009; Nasir et al., 2003; Sambasivan and Soon, 2007; Sweis et al., 2014; Takim, 2002; Yu et al., 2019). External factors influencing the performance of construction projects are listed in Table 1.

Table 1. External Factors

Factor	Code	References
Unavailability of desired quality materials in the market	DQM	Enshassi et al. (2009); Hatmoko and Scott (2010)
Material price fluctuations	MPF	Chileshe and Boadua Yirenkyi-Fianko (2012); Enshassi et al. (2009); Khodeir and Mohamed (2015); Luu et al. (2009); Sweis et al. (2014)
Delayed approval by the authority	AAT	Larsen et al. (2016); Sweis et al. (2014)
Government policy changes	GPC	Chileshe and Boadua Yirenkyi-Fianko (2012); Khodeir and Mohamed (2015); Sweis et al. (2014)
External parties' disturbance (example: difficulties in the clearance of slums)	EPD	Sambasivan and Soon (2007); Takim (2002)
Difficult accessibility to site and transportation	AST	Enshassi et al. (2009); Khodeir and Mohamed (2015); Nasir et al. (2003); Yu et al. (2019)
Unavailability of amenities for construction site (such as water, electricity)	ACS	Khodeir and Mohamed (2015)

Factor	Code	References
Unfavourable weather condition	WCD	Amusan et al. (2018); Chileshe and Boadua Yirenkyi-Fianko (2012); Luu et al. (2009); Enshassi et al. (2009); Sambasivan and Soon (2007)
Occurrence of unexpected disaster (such as earthquakes, pandemics)	OUD	Amusan et al. (2018); Khodeir and Mohamed (2015); Nasir et al. (2003)

Client-related factors

The client is one of the main stakeholders responsible for achieving project success. Even though the client does not practically construct the building, the client's attributes impact the construction process and performance outcomes (Soetanto, 2002). Because the present study focuses on public housing, the local government departments were considered the clients. Given that Myanmar public housing buildings were constructed following the standard design of the DUHD (JICA, 2018), the design-related factors, such as incomplete designs, drawings and specifications, were listed under the client-related factors (see Table 2). Moreover, government departments usually have hierarchical processes in payment, decision-making, and communication, which can lead to project delays (Enshassi et al., 2009; Hwang et al., 2013; Sambasivan and Soon, 2007; Sweis et al., 2014). The potential client-related factors influencing PHCPM performance are summarised in Table 2.

Table 2. Client-related factors

Factor	Code	References
Client's poor communication and cooperation	CCC	Enshassi et al. (2009); Sweis et al. (2014)
Client's inappropriate construction timeline	CCT	Hwang et al. (2013); Rachid et al. (2019)
Incompleteness of tender documents by client	CTD	Sambasivan and Soon (2007)
Client's delayed or unclear decision-making	CDM	Hwang et al. (2013); Khodeir and Mohamed (2015); Nasir et al. (2003); Sambasivan and Soon (2007); Sweis et al. (2014)
Delays in site handover by the client at the start of the project	CSH	Amusan et al. (2018); Sweis et al. (2014)

Factor	Code	References
Delays in progress payment by client	CPP	Chileshe and Boadua Yirenkyi-Fianko (2012); Enshassi et al. (2009); Hwang et al. (2013); Khodeir and Mohamed (2015); Luu et al. (2009); Nasir et al. (2003); Sambasivan and Soon (2007); Sweis et al. (2014)
Incomplete design drawing and specification	CDS	Enshassi et al. (2009); Aibinu and Odeyinka (2006)
Scope of work changed by client	CSC	Amusan et al. (2018); Chileshe and Boadua Yirenkyi-Fianko (2012); Sambasivan and Soon (2007); Sweis et al. (2014)
Client lacks or has poor-quality management system	CMS	Chileshe and Boadua Yirenkyi-Fianko (2012); Hwang et al. (2013)

Contractor-related factors

Because the main contractor oversees and manages the construction process, project success is often the responsibility of the contractor (Sweis et al., 2014). Hwang et al. (2013) claimed that a contractor's site management is the most important factor that should be considered to improve construction projects. Moreover, other research studies have indicated that technical capabilities, financial background soundness and experience affect the performance of construction projects (Alzahrani and Emsley, 2013; Aragonés-Beltrán et al., 2017; Larsson, 2018; Sweis et al., 2014). Contractor-related factors are listed in Table 3.

Table 3. Contractor-related factors

Factor	Code	References
Contractor's poor communication and information sharing	CoCI	Enshassi et al. (2009); Sweis et al. (2014)
Contractor is in a difficult financial situation	CoFS	Aibinu and Odeyinka (2006); Hwang et al. (2013); Luu et al. (2009); Sweis et al. (2014)
Contractor lacks or has poor ability of planning and scheduling	CoPS	Amusan et al. (2018); Hwang et al. (2013); Khodeir and Mohamed (2015); Sambasivan and Soon (2007); Sweis et al. (2014)

Factor	Code	References
Contractor lacks or has poor management capabilities	CoMC	Chileshe and Boadua Yirenkyi-Fianko (2012); Hwang et al. (2013); (Yu et al., 2019); Sambasivan and Soon (2007)
Contractor lacks or has poor technical capability	CoTC	Nasir et al. (2003); Sweis et al. (2014)
Contractor lacks or has poor knowledge and skills	CoKS	Luu et al. (2009); Nasir et al. (2003); Sweis et al. (2014)
Delayed or unclear decision-making by contractor	CoDM	Alzahrani and Emsley (2013); Enshassi et al. (2009);
Contractor lacks or has poor experience	CoEX	Amusan et al. (2018); Enshassi et al. (2009); Hwang et al. (2013); Luu et al. (2009); Nasir et al. (2003); Sambasivan and Soon (2007)
Insufficient equipment provision by contractor	CoEP	Nasir et al. (2003); Sweis et al. (2014)
Use of low-quality materials	CoQM	Enshassi et al. (2009); Sambasivan and Soon (2007); Yu et al. (2019)
Use of inappropriate construction method	CoCM	Chileshe and Boadua Yirenkyi-Fianko (2012); Hwang et al. (2013); Khodeir and Mohamed (2015); Luu et al. (2009); Sambasivan and Soon (2007); Sweis et al. (2014)

Consultant-related factors

In PHCPM, a consultant is a third-party client-side inspector. The consultant's responsibility is to check the construction process and progress and determine whether the work meets the required quality and specifications mentioned in the drawings and contracts (JICA, 2018). If the consultant fails to conduct a timely check of the contractor's work and lacks the necessary experience and decision-making skills, this may result in many unfavourable outcomes, such as delays in schedules and poor-quality work (Chileshe and Boadua Yirenkyi-Fianko, 2012; Hwang et al., 2013; Sambasivan and Soon, 2007). Potential consultant-related factors that could impact Myanmar public housing construction projects are listed in Table 4.

Table 4. Consultant-related factors

Factor	Code	References
Consultant lacks or has poor experience	CsEX	Hwang et al. (2013)
Consultant lacks or has poor management capability	CsMC	Chileshe and Boadua Yirenkyi-Fianko (2012); Hwang et al. (2013)

Factor	Code	References
Delayed or ineffective inspection by consultant	CsIS	Luu et al. (2009); Sambasivan and Soon (2007); Sweis et al. (2014); Yu et al. (2019)
Delayed or unclear decision-making by consultant	CsDM	Sambasivan and Soon (2007); Sweis et al. (2014)

Material supplier-related factors

A supplier plays a key role in construction projects in developing countries, where most construction materials are imported from abroad. Even though the suppliers are not the decision-makers in construction projects, their performance impacts the construction process and schedule, especially when the delivery of material is delayed (Sweis et al., 2014). If a supplier fails to deliver materials on time, the construction site may not be able to move forward with the project, leading to delays and cost overruns. Delivering construction materials on time is, therefore, an essential quality of a supplier. Other supplier-related factors, such as responsiveness and reliability, are most responsible for poor quality and time delays in construction projects (El-khalek et al., 2019; Hatmoko and Scott, 2010; Takim, 2002). Furthermore, poor-quality materials can lead to a decrease in the quality of the finished product and may even require costly repairs down the line (Hatmoko and Scott, 2010; Takim, 2002). Supplier-related factors that potentially impact project output are listed in Table 5.

Table 5. Material supplier-related factors

Factor	Code	References
Poor responsiveness of suppliers	SuRP	Hatmoko and Scott (2010); Takim (2002)
Delays in delivery of materials by suppliers	SuDM	El-khalek et al. (2019); Hatmoko and Scott (2010); Sweis et al. (2014); Gebrehiwet and Luo (2017)
Poor delivery precision in quality and quantity by suppliers	SuDP	Hatmoko and Scott (2010); Takim (2002)

Subcontractor-related factors

A subcontractor performs part of the main contractor's work, such as installing electrical and mechanical equipment, civil work and providing materials, equipment and labour (Min-Yuan Cheng, 2011; Ng and Tang, 2010). A lack of technical capability of the subcontractor will result in defective work, which will require rework, thus increasing the cost and

duration of the project (Chen et al., 2023). Maturana et al. (2007) mentioned that poor subcontractor management results in low-quality and scheduling delays in construction projects. For a construction project to be successful, the subcontractor must possess adequate technical knowledge and skills, communicate effectively with the contractor, and prepare effective reports within a reasonable time frame (Alaghbari et al., 2009; El-khalek et al., 2019). Table 6 presents the factors related to subcontractors.

Table 6. Subcontractor-related factors

Factor	Code	References
Subcontractor has poor communication and information sharing	ScCI	Alaghbari et al. (2009); Bingol and Polat (2017); El-khalek et al. (2019); Lew et al. (2018)
Delayed or ineffective reports by subcontractors	ScRP	Alaghbari et al. (2009); Bingol and Polat (2017); Hatmoko and Scott (2010)
Subcontractor lacks or has poor knowledge and skills	ScKS	Bingol and Polat (2017); El-khalek et al. (2019); Tam et al. (2011)
Subcontractor lacks or has poor technical capability	ScTC	Eom et al. (2008); El-khalek et al. (2019); Lew et al. (2018)
Subcontractor lacks or has poor responsibility	ScPR	Bingol and Polat (2017); Lew et al. (2018)

Other factors during the construction process

As a part of the construction process, there are a variety of factors that should be considered, such as a shortage of workers, materials and equipment, defective work, reworking and accidents (Hwang et al., 2013; Luu et al., 2009; Yu et al., 2019). Considering that these factors are not external factors or attributes of any stakeholders, they are considered to be other factors during the construction process. These factors may directly influence the performance of construction projects. For example, a shortage of workers, materials and defective work can lead to time and materials waste and an increase in costs. Furthermore, accidents can cause serious financial losses, as well as physical and psychological damage. Moreover, effective communication between parties is crucial to avoiding misunderstandings and delays in the flow of information. The list of other factors related to the construction process is shown in Table 7.

Table 7. Other factors during the construction process

Factor	Code	References
Shortage of workers	STW	Nasir et al. (2003); Sweis et al. (2014)
Shortage of skilled workers	SCW	Nasir et al. (2003); Hatmoko and Scott (2010); Sweis et al. (2014); Yu et al. (2019)
Defective materials	DFM	Chileshe and Boadua Yirenkyi-Fianko (2012)
Shortage of materials	STM	Chileshe and Boadua Yirenkyi-Fianko (2012); Enshassi et al. (2009); Sambasivan and Soon (2007); Nasir et al. (2003); Sweis et al. (2014)
Shortage of equipment	STE	Luu et al. (2009); Nasir et al. (2003); Sweis et al. (2014); Yu et al. (2019)
Delays in schedule	DSC	Luu et al. (2009); Sambasivan and Soon (2007); Gündüz et al. (2013), Hossen et al. (2015); Larsen et al. (2016); Gebrehiwet and Luo (2017); Marzouk Mohamed (2018)
Labour injuries and accident	LIA	Enshassi et al. (2009); Nasir et al. (2003);
Reworking	REW	Enshassi et al. (2009); Luu et al. (2009); Nasir et al. (2003)
Defective work	DFW	Enshassi et al. (2009); Luu et al. (2009); Khodeir and Mohamed (2015); Nasir et al. (2003); Yu et al. (2019)
Poor coordination and communication among the stakeholders	CCS	Chileshe and Boadua Yirenkyi-Fianko (2012); Enshassi et al. (2009); Hwang et al. (2013); Jha and Iyer (2006); Sambasivan and Soon (2007)

METHODOLOGY

Following a critical review of the literature, 51 factors influencing the performance of construction projects were identified, and a questionnaire was developed based on these factors. A questionnaire survey was utilised to collect the data, which were then analysed using a series of statistical

analysis methods, including one-way ANOVA and FAII analysis, to check the uniformity among the respondent's opinions (Denis, 2016) and to rank the factors according to frequency-adjusted important index levels (Gunduz and Ahsan, 2018), respectively.

Questionnaire Design

A list of 51 factors was utilised to develop the questionnaire. The questionnaire included four main parts:

1) General information about the respondents: This section collects demographic information about the respondents, such as their years of experience, current positions, and number of housing projects in which they were involved.

2) General information about the project: In this section, the respondents were asked to think about a recently finished project and answer questions about the location of the project, as well as the level of performance outcomes regarding cost, time and quality.

3) Evaluation of the factors: This section asked the respondents to evaluate the 51 factors extracted from the literature review based on their experience with the recent projects they were involved in. Two 5-point Likert scales were used to evaluate factors based on their 'level of impact' on the performance of PHCPM and their 'frequency of occurrence' during the construction of the project. The aim was to account for the effect from factors that would have a great impact but may not frequently occur and factors that have a minor impact but frequently occur. A scale with 'very low impact (1)' to 'very high impact (5)' for the level of impact and a scale with 'almost never (1)' to 'very often (5)' for the frequency of occurrence of the factors were used.

4) Invitation for further research: This is the final section of the questionnaire and is intended to invite participants to participate in a focus group discussion for the purpose of conducting further research. The respondents were able to provide their contact information if they were interested in participating in the focus group discussion.

The questionnaire was translated into the local language (Burmese). The survey was conducted both online and on paper. As for the online survey, a link to a web-based platform, as well as an online PDF form, was sent to the respondents. There was also a printed version of the form available to those who were able to receive them in person.

Data Collection

Snowball sampling was used for the data collection because the type of respondents was specific, meaning they had to have experience with public housing construction in Myanmar. Snowball sampling is a non-probabilistic sampling technique in which the initial participants refer others from their acquaintances to participate in the study (Kumar, 2018). The targeted groups

of respondents were clients, consultants, main contractors and subcontractors. The respondents were engineers, managers and individuals in higher positions. Data were collected across the country where public housing construction projects were underway, such as Yangon (the largest commercial city in Myanmar), Mandalay (the second largest city) and Nay Pyi Taw (the capital city).

Data Analysis Methods

FAII is an advanced ranking method of the relative importance index (RII) and is similar to the approach used by Gunduz and Ahsan (2018), Hwang et al. (2013) and Le-Hoai et al. (2008). The selection of this method for the study was based on its ability to assess each factor on two distinct scales: 'level of impact' and 'frequency of occurrence'. This approach facilitates the ranking of factors by considering their importance, as determined by these two scores. A FAII score can be obtained by multiplying the frequency index (FI) and important index (RII) scores using equations (1–3) (Gunduz and Ahsan, 2018).

$$FI\ (\%) = \frac{\sum W_{freq}}{AxN} x100\% \quad (1)$$

$$RII\ (\%) = \frac{\sum W_{imp}}{AxN} x100\% \quad (2)$$

$$FAII\ (\%) = \frac{RII x FI}{100} \quad (3)$$

where:
FI = frequency index
RII = relative importance index
FAII = frequency-adjusted importance index
W_{freq} = weight of frequency given to each factor by the respondents (1–5)
W_{imp} = weight of impact given to each factor by the respondents (1–5)
A = the highest weight (5 in this case)
N = total number of respondents

In the present study, two types of FAII scores were calculated: 'individual FAII score' to perform a one-way ANOVA and 'average FAII score' to rank the factors. A one-way ANOVA was conducted prior to the FAII analysis to check the respondents' opinions and whether all groups of respondents were in agreement about how important each factor was. The calculation of individual FAII scores was adopted from the calculation of the FAII scores in equations (1–3). An individual FAII score is similar to the FAII score, but it is calculated for each case, while the FAII score (in equation 3) is

the calculated average of all cases. A one-way ANOVA was then carried out based on the individual FAII scores. As a result, those factors with significant levels greater the specified threshold were removed because such result indicated that all groups could not agree on the level of importance of these factors. The remaining factors were then ranked using the overall FAII scores to identify the critical factors.

The 'average FAII scores' were calculated for all respondent groups and for the whole set of data (overall FAII). The overall FAII scores were sorted from the largest to smallest numbers and ranked in order. The factors with the above-mean FAII scores were selected as critical factors. Finally, the critical factors were identified and discussed to provide valuable information for the individuals responsible for improving the performance of PHCPM.

DATA ANALYSIS

Preliminary Findings

A total of 100 responses were collected from the survey. Among these, 14 were removed because of significant incompleteness. Therefore, a total of 86 valid responses were included for the analysis. Based on the sample sizes from existing studies, ranging from 19 to 238 for RII/FAII analysis (Hossen et al., 2015; Hwang et al., 2013; Gunduz et al., 2013; Gebrehiwat et al., 2017; Le-Hoai et al., 2008; Wu et al., 2019; Gunduz, 2018), the sample size of 86 in this study can be considered appropriate for FAII analysis.

The 86 responses were categorised into four groups: 14 clients (16%), 18 consultants (21%), 36 contractors (42%), and 18 subcontractors (21%). Among the respondents from the public sector (client), there were two managing directors, four deputy directors, four assistant directors, one executive engineer, two senior engineers/architects and one quality controller. There were 12 CEOs/MDs, nine project managers, 15 senior engineers/architects and 36 engineers/architects in the private sector (consultants, contractors and subcontractors). The total years of experience in public housing construction can be divided into four groups: 30% with less than three years of experience, 50% with 3–10 years of experience, 12% with 11–20 years of experience and 8% with more than 20 years of experience.

The data were collected from various regions of the country where the public housing construction projects were located. Approximately 65% of the projects are located in Yangon, 18% in Mandalay, 6% in Nay Pyi Taw and 11% in other regions. Figure 2 illustrates the respondents' perceptions of PHCPM's performance. There was a high rate of project delays and cost overruns. More than half of the respondents (55%) experienced project delays at a medium to high level. The second phenomenon is cost overruns, with 50% of the respondents experiencing medium to high levels of cost overruns. However, in the case of quality, only 28% reported medium to high levels of poor quality. Approximately 72% of the respondents indicated no or low levels of inferior quality, meaning that the quality of construction was perceived as

satisfactory by most of the respondents. According to the survey, there is still room for improvement in the performance of PHCPM, particularly in terms of cost and time. Although quality is satisfactory compared with time and cost, it also requires improvement because more than 28% of respondents experienced medium to high levels of inferior quality.

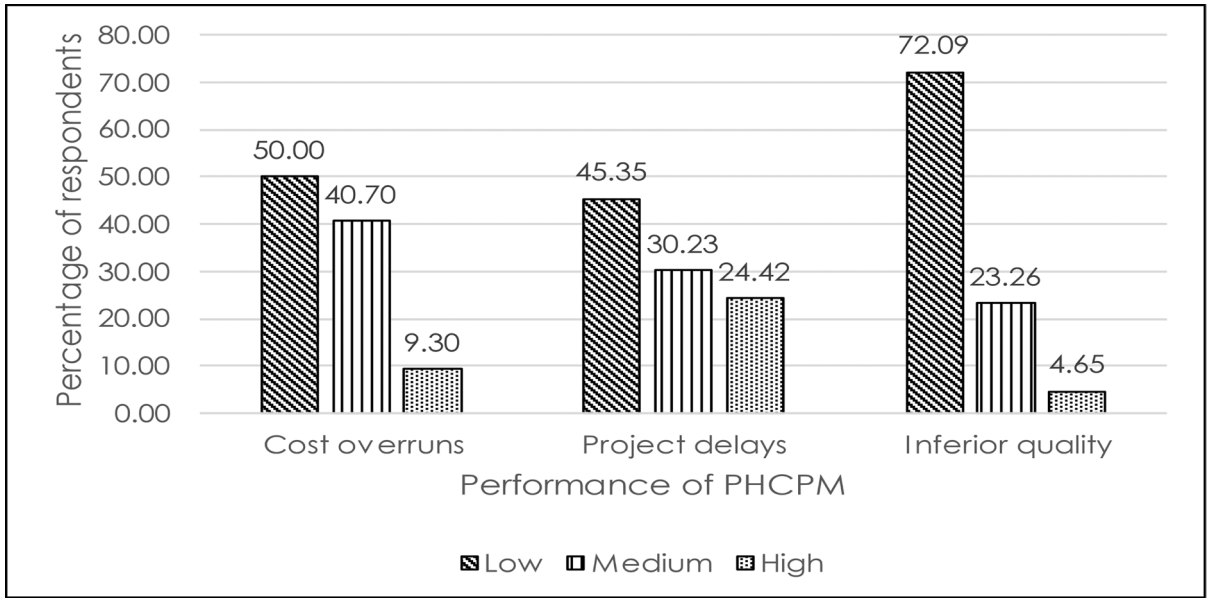

Figure 2. Respondents' perceptions of PHCPM performance

One-way ANOVA

Before performing the ANOVA and FAII, the internal consistency of the factors was assessed using Cronbach's alpha to check the reliability of the measurements. In general, reliability refers to how consistently a measurement measures a concept, and Cronbach's alpha is a way to measure the degree of consistency. A Cronbach's alpha value greater than 0.7 indicates a strong relationship across the factors (Hair, 2009). In the present study, Cronbach's alpha ranged from 0.846 to 0.946, indicating a high degree of consistency across the factors for each group.

The assumptions of normality and homogeneity were also evaluated before conducting a one-way ANOVA. The values of the 'level of impact' measures ranged from -0.569 to 0.585 for skewness and -1.138 to 0.765 for kurtosis. For the 'frequency of occurrence' measures, the values ranged from -0.51 to 0.985 for skewness and -0.819 to 1.93 for kurtosis. The values should range between ± 2.0 for both skewness and kurtosis, which is in accordance with the assumption of normality (Garson, 2012). Therefore, the values of all variables fell within the recommended range. Moreover, the P-values of all

homogeneity tests were greater than 0.05; therefore, the homogeneity of variance assumption was also met, and ANOVA was conducted accordingly (Denis, 2016).

ANOVA analysis was conducted to determine if there was any significant difference between the responses from the client, consultant, contractor and subcontractor groups. A factor is considered statistically significant if its P-value was less than 0.05 for a 95% confidence interval (Hair, 2009). The ANOVA outcomes, including the F-value and P-value for each factor, are provided in Table 8. Initially, out of the total factors, 22 exhibited significant P-values as an outcome of the one-way ANOVA procedure.

In addition, it is suggested to consider effect size for the statistical power of ANOVA analysis to correct for potential Type I errors (Hansen and Collins, 1994; Sullivan and Feinn, 2012). Partial eta squared, η_p^2, can be calculated to determine the effect size and whether it is large enough to be considered practically significant. It can be obtained by dividing the sum of squares between groups by the total sum of squares. A factor is considered practically significant if the size of the partial eta square is large, which means greater than 0.14 (Cohen, 1988).

Therefore, the factors with P-value less than 0.05 and partial eta squared (η_p^2) greater than 0.14 were considered significant and removed from the list of factors. Here, 13 out of 51 factors were significant in both the P-value and effect size, as shown in Table 8. The factors with significant values were removed from the list, and the remaining factors were ranked according to the FAII analysis.

FAII Analysis

The 'average FAII scores' for each stakeholder group and overall were calculated using equation (3), as shown in Table 8. The overall FAII scores ranged from 45.24 to 21.33. The factors were ranked with overall FAII scores ranging from largest to lowest. The medium value of the FAII score was used as a cut-off point, and the factors above the cut-off point were considered critical. The medium scores of a factor for both the 'level of impact' and 'frequency of occurrence' scales must be at least 3, giving the RII and FI scores 60% for each (using equations 1 and 2). Therefore, the overall FAII score for a critical factor must be at least 36% (RII 60% and FI 60%). The critical factors are discussed in the next section.

Table 8. Results of one-way ANOVA, FAII scores, and factor ranking

Factor Code	Results of one-way ANOVA analysis			Results of FAII analysis (Average FAII scores)					Factor Rank
	F	Sig. (P-value)	η_p^2 (Partial eta squared)	Client	Consultant	Contractor	Sub-contractor	Overall	
MPF	1.187	0.32	0.042	47.96	42.87	47.19	39.41	45.24	1
AAT	1.476	0.227	0.051	42.24	56.49	42.35	36.73	42.34	2

Factor Code	Results of one-way ANOVA analysis			Results of FAII analysis (Average FAII scores)					Factor Rank
	F	Sig. (P-value)	η_p^2 (Partial eta squared)	Client	Consultant	Contractor	Sub-contractor	Overall	
CoFS	3.293	0.025*	0.108	50.00	56.44	40.50	35.26	42.22	3
CSC	2.704	0.051	0.090	36.86	60.08	39.01	45.38	41.76	4
CPP	3.231	0.027*	0.106	29.47	58.26	43.36	40.91	41.67	5
DSC	3.349	0.023*	0.109	48.00	56.08	37.67	40.84	41.55	6
CDS	0.336	0.799	0.012	44.12	39.19	39.68	43.70	41.18	7
CCT	2.516	0.064	0.084	33.47	55.93	36.15	33.16	38.72	8
SuDM	2.335	0.080	0.079	39.45	40.51	37.53	28.97	37.22	9
STW	4.346	0.007*	0.137	43.92	54.21	32.88	31.46	36.50	10
GPC	0.262	0.853	0.009	38.61	34.29	33.33	36.52	34.94	11
DQM	2.724	0.049*	0.091	34.90	48.74	31.12	34.52	33.98	12
ScCI	4.502	0.006	0.140	41.12	43.16	33.49	22.72	33.06	13
CMS	2.515	0.064	0.084	30.24	50.22	31.89	31.14	33.00	14
REW	0.616	0.607	0.022	35.26	38.29	31.45	31.82	32.80	15
CCS	2.098	0.107	0.071	40.85	39.13	30.09	28.39	32.22	16
CoEP	3.894	0.012*	0.125	35.98	50.15	29.82	27.60	32.03	17
CCC	1.780	0.157	0.061	32.63	44.92	30.54	29.93	31.99	18
STM	1.189	0.319	0.042	39.04	29.60	31.04	27.48	31.39	19
CTD	0.956	0.417	0.034	28.57	24.40	31.35	35.98	31.22	20
SuRP	2.796	0.045*	0.093	33.99	43.24	30.62	25.53	31.15	21
AST	0.575	0.633	0.021	33.47	31.95	29.53	26.86	29.91	22
CSH	1.052	0.374	0.037	30.24	39.78	28.32	26.20	29.27	23
ACS	2.245	0.089	0.076	33.43	41.23	27.41	23.60	28.70	24
CsDM	0.274	0.844	0.010	31.90	30.28	26.03	27.86	27.74	25
CsIS	0.210	0.889	0.008	28.07	28.01	27.89	26.62	27.69	26
EPD	3.489	0.019*	0.113	40.29	32.11	26.72	19.05	27.55	27
WCD	0.838	0.477	0.03	30.80	32.27	25.79	26.61	27.35	28
DFM	1.338	0.268	0.047	32.21	28.13	26.94	23.27	27.12	29
SuDP	2.266	0.087	0.077	35.63	31.78	26.68	20.19	27.04	30
LIA	1.099	0.354	0.039	29.8	22.58	27.81	24.55	26.96	31
STE	2.625	0.056	0.088	32.95	33.50	26.47	20.41	26.74	32
CoEX	3.800	0.013*	0.122	26.43	45.89	23.05	26.02	26.05	33
DFW	1.036	0.381	0.037	32.26	21.17	25.27	22.60	25.38	34
CoCM	4.408	0.006*	0.139	34.12	42.23	21.30	21.41	24.97	35
OUD	0.675	0.570	0.024	29.84	25.47	24.68	20.91	24.74	36
CsMC	0.336	0.799	0.012	20.03	27.95	22.11	21.67	22.27	37
CsEX	0.184	0.907	0.007	21.27	26.63	20.37	21.47	21.33	38
CDM	4.747	0.004*	0.148**	22.90	53.60	34.40	33.9	Removed	-
CoCI	6.641	0.000*	0.195**	40.41	57.62	30.74	28.23	Removed	-
CoPS	9.456	0.000*	0.257**	47.00	57.77	28.94	38.47	Removed	-
CoMC	6.388	0.001*	0.189**	38.61	51.78	26.9	29.71	Removed	-
CoTC	6.092	0.001*	0.182**	34.31	55.32	27.78	28.79	Removed	-
CoKS	5.24	0.002*	0.161**	33.47	49.83	26.43	26.32	Removed	-

Factor Code	Results of one-way ANOVA analysis			Results of FAII analysis (Average FAII scores)					Factor Rank
	F	Sig. (P-value)	η_p^2 (Partial eta squared)	Client	Consultant	Contractor	Sub-contractor	Overall	
CoDM	4.865	0.004*	0.151**	27.18	49.93	28.76	25.41	Removed	-
CoQM	5.419	0.002*	0.165**	39.43	47.34	24.22	21.17	Removed	-
ScRP	5.606	0.002*	0.170**	47.87	45.27	32.13	24.88	Removed	-
ScKS	7.821	0.000*	0.222**	45.01	52.47	35.80	24.42	Removed	-
ScTC	4.962	0.003*	0.154**	38.41	50.24	31.73	25.87	Removed	-
ScPR	7.958	0.000*	0.225**	45.85	55.62	33.74	21.01	Removed	-
SCW	4.627	0.005*	0.144**	51.05	62.10	37.36	36.68	Removed	-

*Significant (P-value> 0.05), **Significant (Effect size > 0.14)

RESULTS AND DISCUSSION

There are 10 critical factors with FAII scores above 36. These critical factors have significantly higher scores than the other factors, indicating that they have a larger influence on performance than the other factors. Because there are a total of 51 factors, the top 10 factors are approximately 20% of the total factors. This is consistent with the Pareto principle: 80% of outcomes (the performance) resulted from 20% of all causes (the influence factors). Therefore, those critical factors caused 80% of the underperformance of PHCPM. Based on housing surveys and reports reflecting the current situation in Myanmar and academic journal publications concerning the performance of construction projects in other countries, the critical factors are discussed further below.

1. Material price fluctuations (MPF): The instability of material prices stood as the most critical factor affecting the performance of PHCPM. There is a possibility that this has been happening because of the depreciation of the Myanmar currency, the disruption of the supply chain and the spill-over effects of higher transport prices (The World Bank, 2022). Akanni et al. (2019) and Luu et al. (2009) stated that, in Nigeria and Vietnam, the instability of material prices caused cost overruns and construction project delays.
2. Delayed approval by the authority (AAT): 'Delayed approval by authority' is the second critical factor in public housing construction in Myanmar. To improve the performance of public construction projects, the approval from the proper authority should be taken into consideration (Larsen et al., 2016). Although the public construction industry in Myanmar has developed since 2011, it still has a delay in the approval of the higher-level government.
3. Contractor is in a difficult financial situation (CoFS): If the contractor is in a difficult financial situation, the construction work could be difficult to continue in a timely manner and may even cause disputes among the stakeholders. Accordingly, the financial stability of the contractor is one of the most important factors affecting the performance of

construction, as mentioned in the studies by Aibinu and Odeyinka (2006), Hwang et al. (2013) and Sweis et al. (2014).

4. Scope of work changed by client (CSC): Because the public housing project is subject to budget constraints, the government usually awards the project to the lowest bidder without specifying the scope of work, which is then changed or extended. Similar problems can be found in other developing countries, such as Nigeria (Mahmud et al., 2021). Therefore, Sweis et al. (2014) and Mahmud et al. (2021) emphasised that frequently changing the scope was one of the most important factors that increased the time and cost of public construction projects.
5. Delays in progress payment by client (CPP): This is one of the factors that can lead to a domino effect in construction operations. In the event that the client fails to make timely payments, the contractor may be unable to pay for resources, resulting in delays in the construction process (Luu et al., 2009). In Myanmar, because of the many levels of quality control and approval by third-party consultants and other administrative procedures involved in public housing construction projects, payment procedures are usually more complicated than those in private construction projects (JICA, 2018).
6. Delays in schedule (DSC): Delays in schedule impact the performance of construction, which is the fourth most important factor according to the results. Many developing countries have also experienced the same problem, such as Vietnam (Luu et al., 2009), Malaysia (Sambasivan and Soon, 2007) and Nigeria (Aibinu and Odeyinka, 2006). There are numerous risks associated with schedule delays, including higher costs and a decrease in quality as a result of rushing the work to meet deadlines.
7. Incomplete designs, drawings and specifications (CDS): Incomplete designs are usually the main reason for project delays in developing countries, such as Nigeria (Aibinu and Odeyinka, 2006) and Algeria (Rachid et al., 2019). In the absence of complete designs, the construction process might not be properly planned, resulting in lower project performance, such as delays and cost overruns because of reworking to correct mistakes.
8. Client's inappropriate construction timeline (CCT): For public housing construction projects, having an appropriate construction timeline, including construction starting time and reasonable construction duration, is essential. In addition to the strict construction time frame specified by the client, there are also unforeseen disruptions, such as slum clearances, unfavourable weather conditions and the obligation to comply with the deadline of the financial year, making it difficult for contractors to meet their obligations in housing construction projects. An unrealistic timeline was also one of the main issues of construction project delays in Algeria (Rachid et al., 2019).

9. Delays in delivery of materials by suppliers (SuDM): According to Hatmoko and Scott (2010), the biggest impact on a construction project's failure was caused by delays in material delivery. The performance of PHCPM is also affected by this problem. This is also one of the most critical factors affecting the cost and schedule performance of construction projects in Ethiopia (Gebrehiwet and Luo, 2017) and Egypt (El-khalek et al., 2019).
10. Shortage of workers (STW): According to Sweis et al. (2014) and Hwang et al. (2013), the shortage of workers adversely affected construction performance, especially regarding delays. Construction projects, especially those in the housing sector, require a large number of labourers simultaneously when they begin. The shortage of workers is also one of the most critical factors affecting Myanmar's housing construction projects. In addition, it was difficult to gather the workforce during the pandemic. Consequently, construction projects were frequently interrupted, causing delays in the completion of the project.

An external factor, 'material price fluctuations', had the greatest influence on the performance of PHCPM. Of the 10 critical factors, four were related to the client (local government), and one was related to the authority (higher-level government). The client was responsible for 'delays in progress payment', 'incomplete designs, drawings and specifications', 'scope of work changed by the client' and 'the client's inappropriate construction timeline'. The government was responsible for 'delayed approval by authority'. Therefore, 5 out of 10 critical factors appear to be the responsibility of the government. Only one critical factor ('contractor is in difficult financial situation') was related to the contractor. The other factors were related to materials, workers and schedule, which are 'delays in delivery of materials by supplier', 'shortage of worker' and 'delays in schedule', respectively.

The critical factors during the construction process were under the categories of external, client-, contractor-, supplier-related factors and other factors during the construction process. In contrast, factors related to subcontractors and consultants were regarded as less important than the critical factors. This is likely because of the limited scope of work and insignificant roles and responsibilities of consultants and subcontractors in PHCPM. As a result, the responsible individuals can focus on the critical factors to develop an actionable plan to improve the performance of PHCPM. The possible strategies are discussed below.

In Myanmar, construction materials were highly imported from other countries, especially steel for reinforced concrete buildings. The result of the political situation and global oil prices in 2021 and reliance on imported materials triggered high fluctuations in material prices in Myanmar (UN, 2022). Additionally, because of low wages, young people migrated to neighbouring countries for higher wages, resulting in a shortage of workers. This challenge was faced by many industries in Myanmar, including the construction

industry. These factors have also been influenced by Myanmar's political climate.

Moreover, public housing construction in Myanmar has not yet implemented digitalisation and other modern technologies, such as BIM and modular construction. Because housing provision is mass produced and requires repetitive work for similar designs, it would be beneficial if the government adopted industrialised building systems (Mandala and Nayaka, 2023). By increasing the adoption of industrialised building systems or prefabricated methods, the government may address housing construction challenges, improve efficiency, enhance quality control and promote sustainable construction practices in the housing sector (Thai et al., 2023).

The lack of advanced technology usage can lead to the absence of efficient communication between contractors and clients, and it will end up with design and scope changes after the construction starts. Applying advanced technologies such as BIM could help overcome unnecessary changes in scope and design in the construction (Latiffi et al., 2015). Also, adopting eGovernment can reduce the time taken to exchange information between government departments (Ndou, 2004). Consequently, timely information can facilitate the decision-making process and help expedite the approval of the authority.

Furthermore, the contractors' financial difficulties adversely impacted the success of construction projects. Most construction companies in Myanmar are SMEs, and they play an important role in the country's economy. Hence, it is recommended that the government or other financial institutions provide financial assistance through low-interest loans (Nyein and Hadikusumo, 2021). The selection of the contractor must be carefully done by considering the financial background soundness of the contractors (Hwang et al., 2013). Moreover, the government should reconsider the construction timeline to be more realistic and appropriate through discussion and negotiation with contractors.

For contractors, a long-term procurement contract can reduce the risks resulting from uncertainty regarding the prices of materials (Hwang et al., 2013). Contractors can benefit from long-term procurement contracts because these types of contracts are more predictable economic environments, reducing the risk of volatile material prices. Additionally, the contract should allow contractors to plan better and make more accurate estimates of the necessary resources needed to complete a project on time.

Most importantly, although the majority of the respondents considered the quality of housing construction to be satisfactory, external parties, such as JICA, reported that it still needs improvement. Perhaps, the respondents answered the questionnaire based on the quality of the projects relative to the budget allocated by the government, or they may not have considered the quality of the product per international standards. Nevertheless, it should be noted that internal and external parties seem to have different perceptions of the quality of projects.

CONCLUSION

Public housing provides a safe and secure place to live for those who cannot afford suitable housing in the private market. Therefore, it is important to improve the performance of PHCPM to spend the allocated budget efficiently and provide good-quality housing for people in need. The survey results indicate that there is room for performance improvement in terms of the time, cost and quality of PHCPM. In total, 10 critical factors were identified and discussed in light of the survey findings: 1) material price fluctuations, 2) delayed approval by authority, 3) contractor in difficult financial situation, 4) scope of work changed by a client, 5) delays in progress payment by the client, 6) delays in schedule, 7) incomplete design drawing and specifications, 8) client's inappropriate construction timeline, 9) delays in delivery of materials by suppliers and 10) shortage of workers.

The government appears to be the most accountable stakeholder for the underperformance of PHCPM because 5 out of 10 critical factors were attributed to the government. For the project to be successful, the government should consider using modern technologies. Furthermore, as a result of contractors' difficult financial situations, problems may arise, such as a labour shortage or material shortage on site. A balance should be struck between the provision of low-interest construction loans and the careful selection of contractors by the government (client). Other critical factors relating to materials, labourers and schedules usually occur during the construction process. It is possible to improve these conditions if the contractor manages them appropriately, and the government may increase the adoption of industrialised building systems or prefabricated methods to solve these issues.

The present study has a few limitations that need to be taken into consideration. First, critical factors may reflect only the current situation of PHCPM. Because public housing construction projects are government initiatives, they are susceptible to government changes. Because there were many unanticipated changes in the politics of Myanmar, the consequences of political changes may affect PHCPM in the future. Therefore, the critical factors must be periodically revised to reflect the effects of various conditions. Additionally, 51% of the total respondents were contractors, so their perceptions may influence the result. An equal sample size for all groups of respondents would yield more accurate results and would be more representative of all of them. In addition, the present study did not explore the causes of ineffective PHCPM practice. It would be beneficial if future studies could address these issues by, for instance, conducting in-depth qualitative studies to understand the underlying causes. Moreover, future studies could explore the interrelationships and evaluate the impact of critical factors on the performance of PHCPM by using statistical modelling methods such as structural equation modelling and system dynamics modelling.

Despite these limitations, the present study contributes to the body of knowledge and practical implications to improve the performance of public housing construction in Myanmar, which has not gained much interest in the research community. This paper has identified the critical factors influencing PHCPM. By conducting a comprehensive empirical study, the current research has provided valuable insights into the key factors that impact PHCPM outcomes, especially in the context of Myanmar, given the scarcity of research. Furthermore, the present study offers actionable recommendations for important stakeholders—the government and contractors—to improve PHCPM performance.

ACKNOWLEDGEMENTS

This research was partially supported by the Chair Professor Grant (P-19-52302) provided by the National Science and Technology Development Agency (NSTDA), Thailand and Center of Excellence in Urban Mobility Research and Innovation, Thammasat University. The first author is also grateful to Sirindhorn International Institute of Technology, Thammasat University for the Excellent Foreign Students (EFS) scholarship support.

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