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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 the 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 is facing these challenges in public housing construction projects. Although many studies have investigated the factors influencing the performance of construction projects, there has been limited research focusing on public housing construction, particularly. Myanmar plans to provide one million homes by 2030. However, the country faces significant challenges, including political instability and the COVID-19 pandemic. This study attempted to identify 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. The results of this study can help inform individuals responsible for taking action to mitigate the impact of the critical factors identified on improving the performance of PHCPM.

Keywords: Critical factors, Construction performance, Public housing in Myanmar, Public housing construction projects, Housing in 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, including for those facing financial hardships. Generally, the type of housing provided by the government is called "public housing", whereas housing 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 study, the term "public housing" is used to refer to all types of housing provided by the government in Myanmar.

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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" (United Nations, 2015: 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 housing 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, Shen and Kong, 2011), Nigeria (Jiboye, 2011) and Malaysia (Hashim et al., 2012). In general, particularly in developing countries, there has been a lack of resources, expertise and budgets, and public housing projects facing 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, 2019). To fulfil the housing needs, the Myanmar government plans to provide one million housing units by 2030 (Rhoads et al., 2020). However, the country is experiencing political instability and post 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 construction projects, it is important to understand the factors influencing their underperformance. By understanding these factors, practitioners can gain insights into the conditions causing the issues in order to 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, including delays (Amoatey et al., 2015; Chen, Lu and Han, 2023; Dick-Sagoe et al., 2023) and cost overruns (Chadee et al., 2022; Sinesilassie, Tabish and Jha, 2018).

Limited studies have focused 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, Tsai and Kobayashi, 2021; Nwal and Panuwatwanich, 2018), history of housing provision (Naing, 2021) and delivery system (Nyein and Hadikusumo, 2021).

To address the research gaps in previous related research, the present study aimed to recommend strategies for improving the performance of public housing construction projects in Myanmar (PHCPM). The study had 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 could offer a systematic and evidence-based understanding of these key factors, recommending possible strategies to the responsible individuals. In addition, the present study addressed the lack of research in the context of public housing construction projects in developing countries, particularly Myanmar and could guide future research endeavours in this field.

This article consists of six sections. The introduction is followed by the literature review 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. The next two sections present the methodology and analysis tools, and explain the data analysis. Finally, the authors present the results and discusses the findings, which leads to the conclusion in the final section.

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 the country's housing shortages and increasing demand for housing (Asian Development Bank, 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%) (Asian Development Bank, 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, 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 will certify approval upon completion of the work. After obtaining the consultant's approval, contractors can take their payment from the client (Japan International Cooperation Agency, 2018).

Issues of Public Housing Construction Projects in Myanmar

According to the Housing Census report, Myanmar's population recorded 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, 2015). Therefore, it is important to promptly address the immediate housing needs of the most disadvantaged individuals living in substandard conditions (Department of Population, 2017).

The progress of public housing construction by the Myanmar government has significantly fallen behind demand, leaving many individuals unable to afford the available units (Rhoads et al., 2020). In addition, the Japan International

Cooperation Agency 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) in 2017 found that some public housing buildings had poor concrete finishing, low precision of the formworks and incomplete overall work (Japan International Cooperation Agency, 2018). In addition, according to a report by the Asian Development Bank in 2019, the climate resilience design for low- and middle-cost housing that could resist cyclones and earthquakes, to which Myanmar is prone, needs to be considered (Asian Development Bank, 2019).

While bank loans were too high for contractors with a 13% interest rate (Asian Development Bank, 2019), they 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 either 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 article) have contributed to further issues affecting the timely and cost-effective completion of PHCPM projects.

Myanmar provided just over 100,000 housing units from 1990 to 2021 (51,649 units from 1990 to 2010 and 50,600 units from 2011 to 2021) (Naing, 2021). In contrast, other Southeast Asian countries have been able to provide a greater number of housing units. Singapore, for example, constructed one million housing units as of 2023, according to the Housing and Development Board (2023). Furthermore, in Thailand, the Bann Eua-Arthorm programme alone produced about 600,000 housing units in 2010 (National Housing Authority, 2023).

Myanmar is still using traditional methods for public housing construction, despite countries in Southeast Asia, such as Thailand and Singapore, having adopted different construction approaches (Housing and Development Board, 2023). The specific methods employed depend on each country's socio-economic context. To improve efficiency, quality and sustainability, innovative techniques such as prefabrication, precast construction, modular construction and digital technology integration have been practised worldwide, including in Southeast Asia (Latiffi, Mohd and Brahim, 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, Ngo and Uy, 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, Lee and Lee, 2008; Luu et al., 2009), Taiwan (Cheng et al., 2011), Ethiopia (Sinesilassie, Tabish and Jha, 2018), Jordan (Sweis et al., 2014), Nigeria (Akanni, Oke and Akpomiemie, 2019) and Saudi Arabia (Assaf and Al-Hejji, 2006). A total of seven groups of factors influencing the performance of construction projects were categorised, namely: (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 were grouped into seven categories, which are summarised in Figure 1. Detailed explanations of the seven categories of influencing factors, along with the corresponding references will be presented in the following sections.

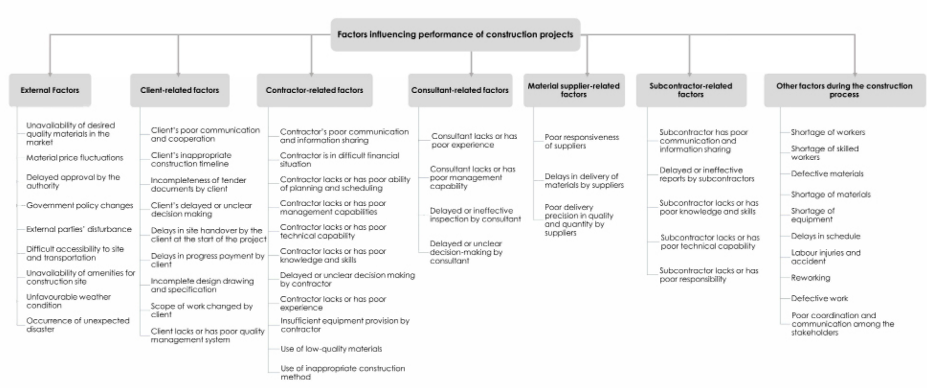

Figure 1. Factors influencing performance of construction projects

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, García-Melón and Montesinos-Valera (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 Yirenkyi-Fianko, 2012; Enshassi, Mohamed and Abushaban, 2009; Hatmoko and Khasania, 2016; Khodeir and Mohamed, 2015; Larsen et al., 2016; Luu et al., 2009; Nasir, McCabe and Hartono, 2003; Sambasivan and Soon, 2007; Sweis et al., 2014; Takim and Akintoye, 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, Mohamed and Abushaban (2009); Hatmoko and Scott (2010)
Material price fluctuations	MPF	Chileshe and Yirenkyi-Fianko (2012); Enshassi, Mohamed and Abushaban (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 Yirenkyi-Fianko (2012); Khodeir and Mohamed (2015); Sweis et al. (2014)
External parties' disturbance (e.g., difficulties in the clearance of slums)	EPD	Sambasivan and Soon (2007); Takim and Akintoye (2002)
Difficult accessibility to site and transportation	AST	Enshassi, Mohamed and Abushaban (2009); Khodeir and Mohamed (2015); Nasir, McCabe and Hartono (2003); Yu et al. (2019)
Unavailability of amenities for construction site (e.g., water, electricity)	ACS	Khodeir and Mohamed (2015)
Unfavourable weather condition	WCD	Amusan et al. (2018); Chileshe and Yirenkyi-Fianko (2012); Luu et al. (2009); Enshassi, Mohamed and Abushaban (2009); Sambasivan and Soon (2007)
Occurrence of unexpected disaster (e.g., earthquakes, pandemics)	OUD	Amusan et al. (2018); Khodeir and Mohamed (2015); Nasir, McCabe and Hartono (2003)

Client-related factors

Client is one of the main stakeholders responsible for achieving project success. Even though a client does not practically construct the building, the client's attributes impact the construction process and performance outcomes (Soetanto, 2002). Because the present study focused 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 (Japan International Cooperation Agency, 2018), the design-related factors, such as incomplete designs, drawings and specifications, were listed under the client-related factors (as shown in Table 2). Moreover, government departments usually have hierarchical processes in payment, decision-making and communication, which can lead to project delays (Enshassi, Mohamed and Abushaban, 2009; Hwang, Zhao and Ng, 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, Mohamed and Abushaban (2009); Sweis et al. (2014)
Client's inappropriate construction timeline	CCT	Hwang, Zhao and Ng (2013); Rachid, Toufik and Mohammed (2019)
Incompleteness of tender documents by clients	CTD	Sambasivan and Soon (2007)
Client's delayed or unclear decision-making	CDM	Hwang, Zhao and Ng (2013); Khodeir and Mohamed (2015); Nasir, McCabe and Hartono (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)
Delays in progress payment by client	CPP	Chileshe and Yirenkyi-Fianko (2012); Enshassi, Mohamed and Abushaban (2009); Hwang, Zhao and Ng (2013); Khodeir and Mohamed (2015); Luu et al. (2009); Nasir, McCabe and Hartono (2003); Sambasivan and Soon (2007); Sweis et al. (2014)
Incomplete design drawing and specification	CDS	Enshassi, Mohamed and Abushaban (2009); Aibinu and Odeyinka (2006)
The scope of work changed by clients	CSC	Amusan et al. (2018); Chileshe and Yirenkyi-Fianko (2012); Sambasivan and Soon (2007); Sweis et al. (2014)
Client lacks or has a poor-quality management system	CMS	Chileshe and Yirenkyi-Fianko (2012); Hwang, Zhao and Ng (2013)

Contractor-related factors

Project success is often the responsibility of the contractor because the main contractor oversees and manages the construction process (Sweis et al., 2014). Hwang, Zhao and Ng (2013) state 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, García-Melón and Montesinos-Valera, 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, Mohamed and Abushaban (2009); Sweis et al. (2014)
Contractor is in a difficult financial situation	CoFS	Aibinu and Odeyinka (2006); Hwang, Zhao and Ng (2013); Luu et al. (2009); Sweis et al. (2014)
Contractor lacks or has a poor ability to plan and scheduling	CoPS	Amusan et al. (2018); Hwang, Zhao and Ng (2013); Khodeir and Mohamed (2015); Sambasivan and Soon (2007); Sweis et al. (2014)
Contractor lacks or has poor management capabilities	CoMC	Chileshe and Yirenkyi-Fianko (2012); Hwang, Zhao and Ng (2013); (Yu et al., 2019); Sambasivan and Soon (2007)
Contractor lacks or has poor technical capability	CoTC	Nasir, McCabe and Hartono (2003); Sweis et al. (2014)
Contractor lacks or has poor knowledge and skills	CoKS	Luu et al. (2009); Nasir, McCabe and Hartono (2003); Sweis et al. (2014)
Delayed or unclear decision-making by the contractor	CoDM	Alzahrani and Emsley (2013); Enshassi, Mohamed and Abushaban (2009);
Contractor lacks or has poor experience	CoEX	Amusan et al. (2018); Enshassi, Mohamed and Abushaban (2009); Hwang, Zhao and Ng (2013); Luu et al. (2009); Nasir, McCabe and Hartono (2003); Sambasivan and Soon (2007)
Insufficient equipment provision by contractor	CoEP	Nasir, McCabe and Hartono (2003); Sweis et al. (2014)
Use of low-quality materials	CoQM	Enshassi, Mohamed and Abushaban (2009); Sambasivan and Soon (2007); Yu et al. (2019)
Use of inappropriate construction method	CoCM	Chileshe and Yirenkyi-Fianko (2012); Hwang, Zhao and Ng (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 the 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 (Japan International Cooperation Agency, 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 Yirenkyi-Fianko, 2012; Hwang, Zhao and Ng, 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, Zhao and Ng (2013)
Consultant lacks or has poor management capability	CsMC	Chileshe and Yirenkyi-Fianko (2012); Hwang, Zhao and Ng (2013)
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 suppliers are not the decision-makers in construction projects, their performance impacts the construction process and schedule, especially when there is a delay in the delivery of material (Sweis et al., 2014). If suppliers fail 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 responsible for poor quality and time delays in construction projects (El-khalek, Aziz and Morgan, 2019; Hatmoko and Scott, 2010; Takim and Akintoye, 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 and Akintoye, 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 and Akintoye (2002)
Delays in delivery of materials by suppliers	SuDM	El-khalek, Aziz and Morgan (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 and Akintoye (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 (Cheng, Tsai and Sudjono, 2011; Ng and Tang, 2010). A lack of technical capability among subcontractors will result in defective work, which will require rework, thus increasing the cost and duration of the project (Chen, Lu and Han, 2023). Maturana et al. (2007) mention 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 and be capable of communicating effectively with the contractor and preparing effective reports within a reasonable time frame (Alaghbari et al., 2009; El-khalek, Aziz and Morgan, 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, Aziz and Morgan (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, Aziz and Morgan (2019); Tam, Shen and Kong (2011)
Subcontractor lacks or has poor technical capability	ScTC	Eom, Yoon and Paek (2008); El-khalek, Aziz and Morgan (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

In a 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, Zhao and Ng, 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 the 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, McCabe and Hartono (2003); Sweis et al. (2014)
Shortage of skilled workers	SCW	Nasir, McCabe and Hartono (2003); Hatmoko and Scott (2010); Sweis et al. (2014); Yu et al. (2019)
Defective materials	DFM	Chileshe and Yirenkyi-Fianko (2012)
Shortage of materials	STM	Chileshe and Yirenkyi-Fianko (2012); Enshassi, Mohamed and Abushaban (2009); Sambasivan and Soon (2007); Nasir, McCabe and Hartono (2003); Sweis et al. (2014)
Shortage of equipment	STE	Luu et al. (2009); Nasir, McCabe and Hartono (2003); Sweis et al. (2014); Yu et al. (2019)
Delays in schedule	DSC	Luu et al. (2009); Sambasivan and Soon (2007); Gunduz et al. (2013); Hossen, Kang and Kim (2015); Larsen et al. (2016); Gebrehiwet and Luo (2017); Mohamed (2018)
Labour injuries and accident	LIA	Enshassi, Mohamed and Abushaban (2009); Nasir, McCabe and Hartono (2003)
Reworking	REW	Enshassi, Mohamed and Abushaban (2009); Luu et al. (2009); Nasir, McCabe and Hartono (2003)
Defective work	DFW	Enshassi, Mohamed and Abushaban (2009); Luu et al. (2009); Khodeir and Mohamed (2015); Nasir, McCabe and Hartono (2003); Yu et al. (2019)
Poor coordination and communication among the stakeholders	CCS	Chileshe and Yirenkyi-Fianko (2012); Enshassi, Mohamed and Abushaban (2009); Hwang, Zhao and Ng (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 analysis of variance (ANOVA) and frequency-adjusted important index (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).

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 collected the demographic information about the respondents, such as their years of experience, current positions and the 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. A total of two five-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 of 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 1 referring to "Very Low Impact" to 5 referring to "Very High Impact" for the level of impact and a scale with 1 indicating "Almost Never" to 5 = "Very Often" for the frequency of occurrence of the factors were used.
4. Invitation for further research: This final section of the questionnaire intended to invite participants to participate in a focus group discussion for 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, which was respondents had to have experience with public housing construction in Myanmar. Snowball sampling is a non-probabilistic sampling technique in which the early 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, Zhao and Ng (2013) and Le-Hoai, Lee and Lee (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 facilitated 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 RII scores using Equations 1 to 3 (Gunduz and Ahsan, 2018).

$$FI\ (\%) = \frac{\sum W_{freq}}{A \times N} \times 100\% \quad \text{Eq. 1}$$

$$RII\ (\%) = \frac{\sum W_{imp}}{A \times N} \times 100\% \quad \text{Eq. 2}$$

$$FAII\ (\%) = \frac{RII \times FI}{100} \quad \text{Eq. 3}$$

where, W_{freq} is the weight of frequency given to each factor by the respondents (1–5), W_{imp} is the weight of impact given to each factor by the respondents (1 to 5), *A* is the highest weight (5 in this case) and *N* is the total number of respondents.

In the present study, two types of FAII scores were calculated: (1) individual FAII score to perform a one-way ANOVA and (2) 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 the importance of each factor. The calculation of individual FAII scores was adopted from the calculation of the FAII scores in Equation 1, Equation 2 and Equation 3. An individual FAII score was similar to the FAII score, but it was calculated for each case, while the FAII score (in Equation 3) was 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 than the specified threshold were removed because the 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 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 responses were removed because of significant incompleteness. As a result, a total of 86 valid responses were included in the analysis. Based on the sample sizes from existing studies, ranging from 19 to 238 for RII/FAII analysis (e.g., Hossen, Kang and Kim, 2015; Hwang, Zhao and Ng, 2013; Gunduz, Nielsen and Özdemir, 2013; Gebrehiwat et al., 2017; Le-Hoai, Lee and Lee, 2008; Wu et al., 2019; Gunduz and Ahsan, 2018), the sample size of 86 in this study could be considered appropriate for FAII analysis.

The 86 responses were categorised into four groups: (1) 14 clients (16%), (2) 18 consultants (21%), (3) 36 contractors (42%) and (4) 18 subcontractors (21%). Among the respondents from the public sector (clients), there were 2 managing directors, 4 deputy directors, 4 assistant directors, 1 executive engineer, 2 senior engineers/architects and 1 quality controller. There were 12 chief executive officers/managing directors, 9 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: (1) 30% with less than 3 years of experience, (2) 50% with 3 years to 10 years of experience, (3) 12% with 11 years to 20 years of experience and (4) 8% with more than 20 years of experience.

The data were collected from various regions in the country where the public housing construction projects were located. Approximately 65% of the projects were 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 was 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, indicating 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 was satisfactory compared with time and cost, it requires improvement because more than 28% of respondents experienced medium to high levels of inferior quality.

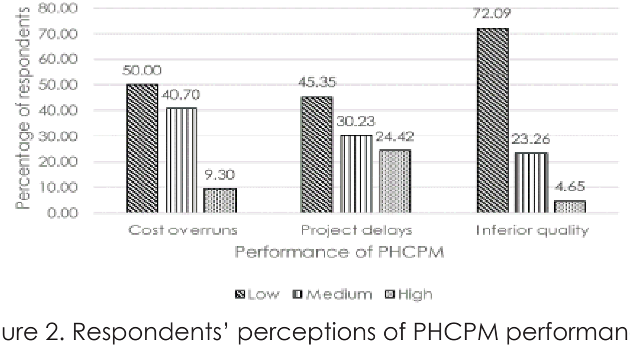

Figure 2. Respondents' perceptions of PHCPM performance

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 its 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 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 per the assumption of normality (Garson, 2012). Therefore, the values of all variables fell within the recommended range. As the *p*-values of all homogeneity tests were greater than 0.05, the homogeneity of variance assumption was also met and ANOVA could be conducted accordingly (Denis, 2016).

ANOVA analysis was conducted to determine any significant difference between the responses from the client, consultant, contractor and subcontractor groups. A factor is considered statistically significant if its *p*-value is 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).

The *p*-value of the current study was 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. As a result, a total of 13 out of 51 factors were considered 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 the level of impact and the frequency of occurrence scales should be at least 3, giving the RII and FI scores 60% for each (i.e., using Equations 1 and 2). Therefore, the overall FAII score for a critical factor must be at least 36%, with 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
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

(*Continued on next page*)

Table 8. *Continued*

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	
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	–

(continued on next page)

Table 8. *Continued*

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	
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	5.240	0.002*	0.161**	33.47	49.83	26.43	26.32	Removed	–
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	–

Note: *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 had significantly higher scores than the other factors, indicating that they had a larger influence on performance than the other factors. Because there was a total of 51 factors, the top 10 factors were approximately 20% of the total factors. This was consistent with Pareto's principle as 80% of outcomes (the performance) resulted from 20% of all causes (the influence factors). Therefore, the 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 were discussed further as follows:

1. Material price fluctuations: The instability of material prices stood as the most critical factor affecting the performance of PHCPM. The possibility of this happening was 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, Oke and Akpomiemie (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: This was the second critical factor in public housing construction in Myanmar. To improve the performance of public construction projects, 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, there was still a delay in the approval from the higher-level government.
3. Contractor is in a difficult financial situation: If a 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 was one of the most important factors affecting the performance of construction, as mentioned in the studies by Aibinu and Odeyinka (2006), Hwang, Zhao and Ng (2013) and Sweis et al. (2014).
4. Scope of work changed by the client: Since a public housing project was subject to budget constraints because the government usually awarded the project to the lowest bidder without specifying the scope of work, which could then be changed or extended. Similar problems were found in other developing countries, such as Nigeria (Mahmud, Ogunlana and Hong, 2021). Therefore, Sweis et al. (2014) and Mahmud, Ogunlana and Hong (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: This was one of the factors leading to a domino effect in construction operations. In the event that a 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 (Japan International Cooperation Agency, 2018).

6. Delays in schedule: This factor impacted the performance of construction, making it 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 were 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: Incomplete designs were usually the main reason for project delays in developing countries such as Nigeria (Aibinu and Odeyinka, 2006) and Algeria (Rachid, Toufik and Mohammed, 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: For public housing construction projects, having an appropriate construction timeline, including construction starting time and reasonable construction duration, was essential. In addition to the strict construction time frame specified by the client, there were 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. Accordingly, an unrealistic timeline was also one of the main issues of construction project delays in Algeria (Rachid, Toufik and Mohammed, 2019).
9. Delays in the delivery of materials by suppliers: 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, Aziz and Morgan, 2019).
10. Shortage of workers: According to Sweis et al. (2014) and Hwang, Zhao and Ng (2013), the shortage of workers adversely affected construction performance, especially regarding delays. Construction projects, especially those in the housing sector, required a large number of labourers simultaneously when they began. The shortage of workers was 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, 4 were related to clients (local government) and 1 was related to the authority (higher-level government). Clients were responsible for "Delays in progress payment", "Incomplete designs, drawings and specifications", "Scope of work changed by the client" and "Client's inappropriate construction timeline". On the other hand, the government was responsible for "Delayed approval by authority". Therefore, 5 out of 10 critical factors appeared to be the responsibility of the government. Only one critical factor, "Contractors in difficult financial situations", was related to contractors.

Other factors were related to materials, workers and schedule, which were "Delays in delivery of materials by suppliers", "Shortage of workers" and "Delays in schedule".

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

In Myanmar, construction materials, especially steel for reinforced concrete buildings, were mostly imported from other countries. The tight political situation, the increase in global oil prices in 2021 and reliance on imported materials triggered high fluctuations in material prices in Myanmar (United Nations, 2022). Additionally, because of low wages, young people migrated to neighbouring countries for higher wages, resulting in the country's shortage of workers. Challenges were faced by many industries in Myanmar, including the construction industry. These factors were also influenced by Myanmar's political climate.

Moreover, public housing construction in Myanmar has yet to implement 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, Ngo and Uy, 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, Mohd and Brahim, 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, contractors' financial difficulties adversely impacted the success of construction projects. Most construction companies in Myanmar are small and medium enterprises 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). Also, the selection of the contractor must be carefully made by considering the financial background soundness of the contractors (Hwang, Zhao and Ng, 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, Zhao and Ng, 2013). Contractors can benefit from long-term procurement contracts because the contracts are more predictable economic environments, reducing the risk of volatile material prices. Additionally, the contracts 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 the Japan International Cooperation Agency, reported that it still needs improvement. Perhaps, the respondents responded to the questionnaire based on the quality of the projects relative to the budget allocated by the government, or they might not have considered the quality of the product per international standards. Nevertheless, it should be noted that internal and external parties shared different perceptions of the quality of projects.

CONCLUSIONS

Public housing provides a safe and secure place for people, especially those who cannot afford suitable housing in the private market, to live. Therefore, it is important to improve the performance of PHCPM to spend the allocated budget efficiently and provide good-quality housing for the people in need. The survey results indicated 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, namely: (1) material price fluctuations, (2) delayed approval by authority, (3) contractors in difficult financial situations, (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 was the most accountable stakeholder for the underperformance of PHCPM because 5 out of 10 critical factors were attributed to the government. Thus, 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 as well as 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 had a few limitations that need to be taken into consideration. First, the critical factors might reflect only the current situation of PHCPM. As 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 might 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 study 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.

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REFERENCES

Aibinu, A.A. and Odeyinka, H.A. (2006). Construction delays and their causative factors in Nigeria. *Journal of Construction Engineering and Management*, 132(7): 667–677. https://doi.org/10.1061/(ASCE)0733-9364(2006)132:7(667)

Akanni, P.O., Oke, A.E. and Akpomiemie, O.A. (2019). Impact of environmental factors on building project performance in Delta State, Nigeria. *HBRC Journal*, 11(1): 91–97. https://doi.org/10.1016/j.hbrcj.2014.02.010

Alaghbari, W.E., Salim, A., Dola, K. and Abdullah Abang Ali, A. (2009). Housing shortage for low-income in Yemen: causes and suggestions. *International Journal of Housing Markets and Analysis*, 2(4): 363–372. https://doi.org/doi:10.1108/17538270910992809

Alzahrani, J.I. and Emsley, M.W. (2013). The impact of contractors' attributes on construction project success: A post-construction evaluation. *International Journal of Project Management*, 31(2): 313–322. https://doi.org/10.1016/j.ijproman.2012.06.006

Amoatey, C.T., Ameyaw, Y.A., Adaku, E. and Famiyeh, S. (2015). Analysing delay causes and effects in Ghanaian state housing construction projects. *International Journal of Managing Projects in Business*, 8(1): 198–214. https://doi.org/10.1108/IJMPB-04-2014-0035

Amusan, L.M., Afolabi, A., Ojelabi, R., Omuh, I. and Okagbue, H.I. (2018). Data exploration on factors that influences construction cost and time performance on construction project sites. *Data in Brief*, 17: 1320–1325. https://doi.org/10.1016/j.dib.2018.02.035

Aragonés-Beltrán, P., García-Melón, M. and Montesinos-Valera, J. (2017). How to assess stakeholders' influence in project management? A proposal based on the analytic network process. *International Journal of Project Management*, 35(3): 451–462. https://doi.org/10.1016/j.ijproman.2017.01.001

Asian Development Bank (2019). *Financing Affordable Housing in Yangon*. https://doi.org/10.22617/TCS190167-2

Assaf, S.A. and Al-Hejji, S. (2006). Causes of delay in large construction projects. *International Journal of Project Management*, 24(4): 349–357. https://doi.org/10.1016/j.ijproman.2005.11.010

Bingol, B.N. and Polat, G. (2017). Measuring managerial capability of subcontractors using a KPI model. *Procedia Engineering*, 196: 68–75. https://doi.org/ 10.1016/j.proeng.2017.07.174

Chadee, A.A., Martin, H.H., Mwasha, A. and Otuloge, F. (2022). Rationalizing critical cost overrun factors on public sector housing programmes. *Emerging Science Journal*, 6(3): 647–666. https://doi.org/10.28991/ESJ-2022-06-03-016

Chen, L., Lu, Q. and Han, D. (2023). A Bayesian-driven Monte Carlo approach for managing construction schedule risks of infrastructures under uncertainty. *Expert Systems with Applications*, 212: 118810. https://doi.org/10.1016/j.eswa.2022.118810

Cheng, M.-Y., Tsai, H.-C. and Sudjono, E. (2011). Evaluating subcontractor performance using evolutionary fuzzy hybrid neural network. *International Journal of Project Management*, 29(3): 349–356. https://doi.org/10.1016/j.ijproman.2010.03.005

Chileshe, N. and Yirenkyi-Fianko, A.B. (2012). An evaluation of risk factors impacting construction projects in Ghana. *Journal of Engineering, Design and Technology*, 10(3): 306–329. https://doi.org/10.1108/17260531211274693

Cohen, J. (1988). *Statistical Power Analysis for the Behavioral Sciences*. New York: Routledge. https://doi.org/10.4324/9780203771587

Denis, D.J. (2016). *Applied Univariate, Bivariate and Multivariate Statistics*. Hoboken, NJ: Wiley. https://doi.org/10.1002/9781119583004

Dick-Sagoe, C., Lee, K.Y., Odoom, D. and Boateng, P.O. (2023). Stakeholder perceptions on causes and effects of public project failures in Ghana. *Humanities and Social Sciences Communications*, 10(1): 14. https://doi.org/10.1057/s41599-022-01497-7

Department of Population (2017). *Thematic Report on Housing Conditions and Household Amenities*. Naypyidaw: Department of Population, The Republic of the Union of Myanmar.

_____. (2015). *The 2014 Myanmar Population and Housing Census, Union Report*. Census report vol. 2. Naypyidaw: Department of Population, The Republic of the Union of Myanmar.

El-khalek, H.A., Aziz, R.F. and Morgan, E.S. (2019). Identification of construction subcontractor prequalification evaluation criteria and their impact on project success. *Alexandria Engineering Journal*, 58(1): 217–223. https://doi.org/ 10.1016/j.aej.2018.11.010

Enshassi, A., Mohamed, S. and Abushaban, S. (2009). Factors affecting the performance of construction projects in the Gaza Strip. *Journal of Civil Engineering and Management*, 15(3): 269–280.

Eom, C.S., Yun, S.H. and Paek, J.H. (2008). Subcontractor evaluation and management framework for strategic partnering. *Journal of Construction Engineering and Management*, 134(11): 842–851.

Garson, G.D. (2012). *Testing Statistical Assumptions*. Asheboro, NC: Statistical Associates Publishing.

Gebrehiwet, T. and Luo, H. (2017). Analysis of delay impact on construction project based on rii and correlation coefficient: Empirical study. *Procedia Engineering*, 196: 366–374. https://doi.org/10.1016/j.proeng.2017.07.212

Gunduz, M. and Ahsan, B. (2018). Construction safety factors assessment through Frequency Adjusted Importance Index. *International Journal of Industrial Ergonomics*, 64: 155–162. https://doi.org/10.1016/j.ergon.2018.01.007

Gunduz, M., Nielsen, Y. and Özdemir, M. (2013). Quantification of delay factors using the relative importance index method for construction projects in Turkey. *Journal of Management in Engineering*, 29(2): 133–139. https://doi.org/10.1061/(ASCE)ME.1943-5479.0000129

Habitat for Humanity (2023). *Affordable Housing*. Available at: https://www.habitat.org/emea/about/what-we-do/affordable-housing

Hair, J.F. (2009). *Multivariate Data Analysis*. 7th Ed. New York: Pearson.

Hansen, W.B. and Collins, L.M. (1994). Seven ways to increase power without increasing N. *American Psychological Association (APA)*. https://doi.org/10.1037/e495862006-008

Hashim, A.E., Samikon, S.A., Nasir, N.M. and Ismail, N. (2012). Assessing factors influencing performance of Malaysian low-cost public housing in sustainable environment. *Procedia – Social and Behavioral Sciences*, 50: 920–927. https://doi.org/10.1016/j.sbspro.2012.08.093

Hatmoko, J. and Scott, S. (2010). Simulating the impact of supply chain management practice on the performance of medium-sized building projects. *Construction Management and Economics*, 28: 35–49. https://doi.org/10.1080/01446190903365632

Hatmoko, J.U.D. and Khasania, R.R. (2016). Comparing performance of government and private clients in construction projects: Contractors' perspective. *Civil Engineering Dimension*, 18(2): 85–92. https://doi.org/10.9744/ced.18.2.85-92

Hossen, M. M., Kang, S. and Kim, J. (2015). Construction schedule delay risk assessment by using combined AHP-RII methodology for an international NPP project. *Nuclear Engineering and Technology*, 47(3): 362–379. https://doi.org/10.1016/j.net.2014.12.019

Housing and Development Board (2023). Public housing: A Singapore icon. Available at: https://www.hdb.gov.sg/

Hwang, B.-G., Zhao, X. and Ng, S.Y. (2013). Identifying the critical factors affecting schedule performance of public housing projects. *Habitat International*, 38: 214–221. https://doi.org/10.1016/j.habitatint.2012.06.008

Jha, K. and Iyer, K. (2006). Critical factors affecting quality performance in construction projects. *Total Quality Management and Business Excellence*, 17(9): 1155–1170.

Jiboye, A. D. (2011). Evaluating public housing performance: providing a basis for residential quality improvement in Nigeria. *Middle-East Journal of Scientific Research*, 9(2): 225–232.

Japan International Cooperation Agency (2018). Myanmar data collection survey on housing finance system report. Available at: https://openjicareport.jica.go.jp/pdf/12305769.pdf

Khodeir, L.M. and Mohamed, A.H.M. (2015). Identifying the latest risk probabilities affecting construction projects in Egypt according to political and economic variables: From January 2011 to January 2013. *HBRC Journal*, 11(1): 129–135. https://doi.org/10.1016/j.hbrcj.2014.03.007

Kumar, R. (2018). *Research Methodology: A Step-By-Step Guide for Beginners*. New York: Sage.

Larsen, J. K., Shen, G. Q., Lindhard, S. M. and Brunoe, T. D. (2016). Factors affecting schedule delay, cost overrun and quality level in public construction projects. *Journal of Management in Engineering*, 32(1). https://doi.org/10.1061/(ASCE)me.1943-5479.0000391

Larsson, J. (2018). The importance of hard project management and team motivation for construction project performance. *International Journal of Managing Projects in Business*, 11(2): 275–288. https://doi.org/10.1108/IJMPB-04-2017-0035

Latiffi, A.A., Mohd, S. and Brahim, J. (2015). Application of building information modeling (BIM) in the Malaysian construction industry: A story of the first government project. *Applied Mechanics and Materials*, 773: 996–1001

Le-Hoai, L., Lee, Y.D. and Lee, J.Y. (2008). Delay and cost overruns in Vietnam large construction projects: A comparison with other selected countries. *KSCE Journal of Civil Engineering*, 12(6): 367–377. https://doi.org/10.1007/s12205-008-0367-7

Lew, Y.-L., Hassim, S., Muniandy, R. and Hua, L.T. (2018). Structural equation modelling for subcontracting practice: Malaysia chapter. *Engineering, Construction and Architectural Management*, 25(7): 835–860. https://doi.org/10.1108/ECAM-04-2017-0073

Li, C.Z., Hong, J., Fan, C., Xu, X. and Shen, G.Q. (2018). Schedule delay analysis of prefabricated housing production: A hybrid dynamic approach. *Journal of Cleaner Production*, 195: 1533–1545. https://doi.org/10.1016/j.jclepro.2017.09.066

Luu, V.T., Kim, S.-Y., Tuan, N.V. and Ogunlana, S.O. (2009). Quantifying schedule risk in construction projects using Bayesian belief networks. *International Journal of Project Management*, 27(1): 39–50. https://doi.org/10.1016/j.ijproman.2008.03.003

Mahmud, A.T., Ogunlana, S.O. and Hong, W.T. (2021). Key driving factors of cost overrun in highway infrastructure projects in Nigeria: A context-based perspective. *Journal of Engineering, Design and Technology*, 19(6): 1530–1555. https://doi.org/10.1108/JEDT-05-2020-0171

Mandala, R.S.K. and Nayaka, R.R. (2023). A state of art review on time, cost and sustainable benefits of modern construction techniques for affordable housing. *Construction Innovation* [Forthcoming]. https://doi.org/10.1108/CI-03-2022-0048

Maturana, S., Alarcón, L.F., Gazmuri, P. and Vrsalovic, M. (2007). On-site subcontractor evaluation method based on lean principles and partnering practices. *Journal of Management in Engineering*, 23(2): 67–74. https://doi.org/10.1061/(ASCE)0742-597X(2007)23:2(67)

McCarty, M. (2014). Introduction to public housing. Available at: https://digital.library.unt.edu/ark:/67531/metadc820996/

Mohamed, M. (2018). Assessing Egyptian construction projects performance using principal component analysis. *International Journal of Productivity and Performance Management*, 67(9): 1727–1744. https://doi.org/10.1108/IJPPM-06-2017-0134

Naing, M. (2021). Brief history of department of urban and housing development: focal institution for housing sector in Myanmar. *Current Urban Studies*, 9(4): 730–743. https://doi.org/10.4236/cus.2021.94043

Naing, Y.M., Tsai, S.L. and Kobayashi, H. (2021). Exploration of potential public housing strategies for low-income households in Yangon, Myanmar. Paper presented at 57th ISOCARP World Planning Congress. Doha, Qatar, 8–11 November.

Nasir, D., McCabe, B. and Hartono, L. (2003). Evaluating risk in construction schedule model: Construction schedule risk model. *Journal of Construction Engineering and Management*, 129(5): 518–527. https://doi.org/10.1061/(ASCE)0733-9364(2003)129:5(518)

National Housing Authority (2023). Baan Eua-Arthon project. Available at: https://www.nha.co.th/en/

Ndou, V.D. (2004). E-government for developing countries: Opportunities and challenges. *he Electronic Journal of Information Systems in Developing Countries*, 18(1): 1–24. https://doi.org/10.1002/j.1681-4835.2004.tb00117.x

Ng, S.T. and Tang, Z. (2010). Labour-intensive construction sub-contractors: Their critical success factors. *International Journal of Project Management*, 28(7): 732–740. https://doi.org/10.1016/j.ijproman.2009.11.005

Nwal, S. and Panuwatwanich, K. (2018). Social housing in myanmar: Issues and way forward. Paper presented at 2018 Joint Asia-Pacific Network for Housing Research and Australasian Housing Researchers Conference Griffith University. Gold Coast, Australia, 6–8 June.

Nyein, T.S. and Hadikusumo, B.H.W. (2021). Factors influencing the adoption of public–private partnership in low-cost housing development in Myanmar. *Journal of Financial Management of Property and Construction*, 26(3): 337–365. https://doi.org/10.1108/jfmpc-01-2020-0003

Rachid, Z., Toufik, B. and Mohammed, B. (2019). Causes of schedule delays in construction projects in Algeria. *International Journal of Construction Management*, 19(5): 371–381. https://doi.org/10.1080/15623599.2018.1435234

Rhoads, E.L., Poine, T.S., Win, C.C. and Kyed, H. (2020). *Myanmar: Urban Housing Diagnostic and COVID-19 Rapid Assessment (English)*. Washington, DC: World Bank Group.

Sambasivan, M. and Soon, YW (2007). Causes and effects of delays in Malaysian construction industry. *International Journal of Project Management*, 25(5): 517–526. https://doi.org/10.1016/j.ijproman.2006.11.007

Sinesilassie, E.G., Tabish, S.Z.S. and Jha, K.N. (2018). Critical factors affecting cost performance: a case of Ethiopian public construction projects. *International Journal of Construction Management*, 18(2): 108–119. https://doi.org/10.1080/15623599.2016.1277058

Soetanto, R. (2002). Modelling the satisfaction of contractors: The impact of client performance. *Engineering, Construction and Architectural Management*, 9(5/6): 453. https://doi.org/10.1108/eb021239

Sullivan, G.M. and Feinn, R. (2012). Using effect size-or why the *p* value is not enough. *Journal of Graduate Medical Education*, 4(3): 279–282. https://doi.org/10.4300%2FJGME-D-12-00156.1

Sweis, R.J., Bisharat, S.M., Bisharat, L. and Sweis, G. (2014). Factors affecting contractor performance on public construction projects. *Life Science Journal*, 11(4): 28–39.

Takim, R. and Akintoye, A. (2002). Performance indicators for successful construction project performance. In D. Greenwood (ed.), *18th Annual ARCOM Conference*, *Vol. 2*. Newcastle upon Tyne: ARCOM, 545–555.

Tam, V.W.Y., Shen, L.Y. and Kong, J.S.Y. (2011). Impacts of multi-layer chain subcontracting on project management performance. *International Journal of Project Management*, 29(1): 108–116. https://doi.org/10.1016/j.ijproman.2010.01.005

Thai, H.-T., Ngo, T. and Uy, B. (2020). A review on modular construction for high-rise buildings. *Structures*, 28: 1265–1290. https://doi.org/10.1016/j.istruc.2020.09.070.

The World Bank (2022). Myanmar economic monitor: Reforms reversed. Available at: https://www.worldbank.org/en/country/myanmar/publication/myanmar-economic-monitor-july-2022-reforms-reversed

United Nations (2022). The Sustainable Development Goals report 2022. Available at: https://unstats.un.org/sdgs/report/2022/

_____. (2015). Transforming our world: The 2030 agenda for sustainable development. Available at: https://sdgs.un.org/2030agenda

Wu, G., Yang, R., Li, L., Bi, X., Liu, B., Li, S. and Zhou, S. (2019) . Factors influencing the application of prefabricated construction in China: From perspectives of technology promotion and cleaner production. *Journal of Cleaner Production*, 219: 753–762. https://doi.org/10.1016/j.jclepro.2019.02.110.

Yu, T., Man, Q., Wang, Y., Shen, G.Q., Hong, J., Zhang, J. and Zhong, J. (2019). Evaluating different stakeholder impacts on the occurrence of quality defects in offsite construction projects: A Bayesian-network-based model. *Journal of Cleaner Production*, 241: 118390. https://doi.org/10.1016/j.jclepro.2019.118390