ICCEPM 2020
The 8th International Conference on Construction Engineering and Project Management
Dec. 7-8, 2020, Hong Kong SAR

Causes of Delay in Tall Building Projects in GCC Countries

Muizz O. Sanni-Anibire[1]*, Rosli Mohamad Zin[2], Sunday Olusanya Olatunji[3]

[1] *Dammam Community College, King Fahd University of Petroleum and Minerals, Dhahran, Kingdom of Saudi Arabia, E-mail address:* muizzanibire@kfupm.edu.sa
[2] *School of Civil Engineering, Faculty of Engineering, Universiti Teknologi Malaysia (UTM), Johor, 81310, Malaysia,* E-mail address: roslizin@utm.my
[2] *College of Computer Science and Information Technology, Imam Abdulrahman Bin Faisal University, Dammam 31441, Kingdom of Saudi Arabia,* E-mail address: osunday@iau.edu.sa

Abstract: The 21st century is witnessing a rapid growth of tall buildings in urban centers globally to create more urban space for an anticipated urban population. Tall buildings, however suffer from incessant delays and sometimes total abandonment. Consequently, this study investigated and ranked the causes of delay in tall building projects, while focusing on the Gulf Cooperation Council (GCC) countries. Initially, 36 common delay causes investigated globally were categorized into 9 groups, and then further ranked utilizing the Relative Importance Index (RII) through a questionnaire survey. Tall building professionals in the GCC countries (Saudi Arabia, United Arab Emirates, Bahrain, Kuwait, Oman and Qatar) were contacted. The respondents' categories include Consultants, Contractors, and Clients' Representatives/Facility Managers. The results reveal that the top three causes include "client's cash flow problems/delays in contractor's payment", "contractor's financial difficulties", and "poor site organization and coordination between various parties". The findings from this study could help construction professionals develop guidelines and controls for delay mitigation, as well as support them in risk-based decision making in the planning of tall building projects.

Key words: tall buildings, gulf cooperation council, construction delays, high-rise buildings

1. INTRODUCTION

Tall buildings have been viewed as a viable solution to creating urban space in areas where there exists concentrated population, scarcity of land, and high land costs. Thus, the current trend is to take advantage of the urban skyline, and as a result, urban centres around the world now feature a huddle of tall building structures [1]. The construction industry, despite its continuous boom is still lagging behind other industries such as the aerospace, automotive and ship building industries. Unfortunately, the fundamental principles of construction have not changed for hundreds of years. Some of the factors influencing this drawback has been identified to include: the continuous fragmentation of the construction industry, globalization of construction, inadequate resources, the need for quality improvement, amongst others.

Problem areas in the construction industry are even more aggravated in the perspective of large construction projects such as tall buildings. In fact, tall building projects can be classified under the general category of large construction projects which are subject to delays [1]. Stakeholders in the industry unanimously agree that the success of a project is determined by the triple constraint of time, cost and quality. Interestingly, the Council on Tall Buildings and Urban Habitat (CTBUH) in its report "Dream Deferred: Unfinished Tall Buildings" noted the alarming rate of increase of "never completed" tall buildings, and further provided a list of 50 projects of 150m or taller that were never completed [2].

At this point, it is noteworthy to mention that there is a gamut of studies addressing the subject of construction delays in the research domain. These studies can be described as country/location and project specific, and the variations in causes of construction delays may be attributed to cultural influences, manpower availability, political instability, project contractual relationships, as well as other factors that are unique to various locations as well as project types [3]. Remarkably, there are limited studies that explore the causes of delay in tall building projects. Experts are of the opinion that identifying the causes of delay, though exploratory in nature, is the first step in mitigating the risk of delays. Some of the studies [4]–[10] that exist are either outdated, or are specific to a regional construction context, and thus it is required that further studies be carried out to explore the phenomenon of construction delay in other construction climates. Remarkably, countries in the GCC have witnessed a surge in tall building projects due to ambitious development plans in infrastructure and facilities with billions of US Dollars in investment [11]. This rapid growth in the region has positioned the GCC as a global leader in tall building construction. Tall buildings in the context of this research is considered as per the definition of The Council of Tall Buildings and Urban Habitat (CTBUH). CTBUH defines a tall building as one exceeding 50m in height, while supertall buildings exceed 300m in height, and mega-tall building exceeding 600m in height [12].

In light of the foregoing, the main objective of this research was to investigate, categorize and rank the causes of delay in tall building projects using the GCC countries as a case study. The study has significant implications for professional practice in delay risk mitigation as well as promote further research in other construction climates. The remainder of this manuscript presents a review of relevant literature, followed by the methodology, the results and findings, a discussion section, and finally conclusions of the study.

2. LITEARTURE REVIEW

The following sections present a brief discussion on the history and evolution of tall building structures in the urban habitat. It also highlights some of the challenges faced by this type of structures, especially the occurrence of delays, and finally summarizes previous work related to construction delays in tall building projects.

2.1 Evolution of Tall Buildings in the Urban Habitat

Humankind has always been fascinated with tall buildings. Ancient structures such as the Tower of Babel, Colossus of Rhodes, the pyramids of Egypt, Mayan temples of Mexico, the Kutub Minar of India and many more were built to show power, pride and probably economic strength [12]. Even today, tall buildings are still the fascination of many nations globally. However, a host of other factors determines the need for tall buildings today. Significantly, global urbanization trends pose the challenge of an increasing pressure on urban housing and infrastructure. According to the United Nations (UN), urbanization will add another 2.5 billion people to urban populations by 2050. It is predicted that global population will rise up to 9 - 11 billion people [13]. Thus, urbanization and population are two parallel trends that suggest the need to optimize already limited resources to develop sustainable solutions for the safety and comfort of the world’s future urban population. Experts are of the opinion that the continuous evolution of tall buildings fits the overall urban sustainability agenda as an inevitable housing solution [14].

Though, the origins of tall buildings in the urban context is evident in many urban cities such as Shibam in Yemen, which is a third century mud brick city with a density of around 300 per hectare, where most buildings are 8 storeys high [15]. The modern tall building traces its origin to the Home Insurance Building, a 10-story steel-framed structure built in Chicago in 1885. The following years witnessed an enthusiastic progression in the development of tall buildings until the Great Depression and World War II years. The drive for building tall re-emerged in the 1960s and has grown steadily into the 21st century. Today, urban centers around the globe are witnessing a rapid re-configuration of the urban skyline. The diversity of such global trend is witnessed in the level of development occurring in places like Shanghai, Shenzhen, Hong Kong, Dubai, Riyadh, Mumbai, London, to name only a few [16]. Most of the development is occurring in booming economies in Asia. China in particular, have massively increased the volume of tall building construction. According to the Council on Tall Buildings and Urban Habitat, of the 143 buildings over 200 meters high completed in 2018, 88 were in China. Similarly, Hong Kong and Singapore are distinguished by their high-rise public housing developments. Besides population growth and urbanization, these countries are also characterized by limited land space, factors which have encouraged these cities to celebrate vertical development. Thus, over a period of 40–50 years, tall buildings have become the dominant building form and life style of the population. For instance, people are used to living in as high as the 40th storey in Hong Kong, while 84% of Singapore's resident population live in tall buildings [14].

2.2 Delays in Tall building Projects

While it is generally acknowledged that tall buildings are a viable solution to urbanization challenges of the 21st century, these buildings also suffer from underperformance issues such as delays. Aibinu and Jagboro [17] define delays as situations where a project's completion time is postponed due to causes that may be related to the client, consultant, and contractor etc. Delays can also be defined as situations were an event occurs at a time later than expected, or to be performed later than planned; or not to take timely actions; or occurring beyond the agreed date specified in the contract. Delays in construction projects have potentially negative effects to all stakeholders including disputes or legal battles in court, cost and time overruns, loss of productivity and revenue, and contract termination [3]. The ambitious and risky nature of tall building projects, has led to a trail of abandoned projects across the globe.

2.2.1 Previous Studies on the Causes of Delay in Tall building Projects

The extant literature is saturated with studies investigating the causes of construction delay. Sanni-Anibire et al., [3] presented a systematic review of construction delay studies carried out globally. These studies were categorized as country/location and project specific. The following is a brief description of previous studies relating to tall building projects.

A pioneer study was carried out by Ogunlana et al., [4] to identify the delays experienced in high-rise building construction projects in Bangkok, Thailand. Structured and unstructured interviews of 30 professionals in 12 construction sites was made, and consequently, 26 causes of delay were identified. The study suggested that developing economies such as Thailand are prone to delays related to: "problems of shortages or inadequacies in resources", "problems caused by clients and consultants" and "problems caused by contractor incompetence/inadequacies". Likewise, Suksai et al., [6] explored the causes of delay in high-rise buildings in Bangkok and its vicinities. Accordingly, sixty three contractors were contacted through questionnaires and interviews. The study concluded that the main causes include "not working together to look as team-work", "delayed delivery area to owner", and "delay approval of drawings and list of construction". Kaming et al., [5] studied the impact of construction time and cost overruns in high-rise construction projects in two Indonesian cities: Jakarta and Yogyakarta. The study identified seventeen variables from previous studies causing construction delays and cost overruns. Interviews were carried out with thirty-one project managers working on high-rise construction projects. The study suggested that the main causes of delays were "design changes", "poor labor productivity" and "inadequate planning". Bhangale, [7] investigated the causes of delay in high-rise building projects in Pune, India. The study reviewed various government reports and suggested that approvals as well as requirements to be fulfilled by developers or builders were the major factors causing delays. A more exploratory research was made by Aaditya and Bhattacharya, [10] on the causes of schedule overruns in high-rise building projects in various cities in India. The study employed a structured questionnaire to obtain the opinions of experts working on real estate high-rise projects in Bangalore, Kolkata, Mumbai and National Capital Region (NCR). The survey contained sixty seven factors of delay, and responses were obtained from 433 participants. The study concluded that the main causes of delay for all locations studied included "material quality", "labor productivity", and "skilled labor availability". Haslinda et al., [8] investigated the factors influencing time and cost overruns for high-rise construction projects in Penang, Malaysia. The study adopted the questionnaire used by Kaming et al., [5], and feedback was obtained from thirty project managers involved in high-rise building projects in Penang. The study concluded that the most predominant causes were due to "design changes", "inadequate planning and scheduling" and "poor labor productivity". Kog [9] sought to explore other research methods as alternatives to questionnaire surveys, and thus reviewed records of 184 high-rise apartment blocks of the public housing agency in Singapore. The study concluded that the "late release of site", "variation orders", "delay by other contractors", "shortage of building materials", "inclement weather", and "others (amenities and facilities not ready)" were the main factors responsible for delay.

3. METHODOLOGY

The methodology employed in this research can be summarily categorized as follows:

3.1. Stage 1: review of the extant literature

A review of literature was carried out to identify the main causes of construction delay to be investigated in this study. Firstly, 11 influential studies were identified for the purpose of outlining the causes of delay. The studies were selected based on their publication in the last 15 years, and high number of citations-an indication of their prominence in the research landscape. Consequently, 36 causes of delay were identified and grouped into nine categories in line with other similar studies.

3.2. Stage 2: Questionnaire design and administration

The identified causes of delay were used to develop a standard questionnaire survey for obtaining the feedback from industry experts. A Likert scale of importance from 1 to 5 was used to design the questionnaire in line with previous studies investigating the causes of delay. Where 1 represents: Least Important (LI), 2: Slightly Less Important (SLI), 3: Moderately Important (MI), 4: Very Important (VI), and 5: Extremely Important (EI). The questionnaire contained three parts, where the first part was meant to obtain demographic information on the respondents, the second part was meant to obtain their feedback on the levels of importance of the various causes of delay, and the third part was meant to obtain open-ended feedback from the respondents. The respondents' categories included Consultants (including Architecture, Structure, Mechanical, Electrical and Plumbing (MEP), and Project Management (PM)), Contractors and Clients' Representatives/Facility Managers. Various strategies were used in distributing the questionnaire survey, this entailed hand delivered hard copies to managers at tall building construction sites, as well as through emails of a web-based format to tall building professionals in the GCC countries. These countries include Saudi Arabia, United Arab Emirates, Bahrain, Kuwait, Oman and Qatar. Since, it is not possible to ascertain the number of tall building professionals in the GCC region, the sample collection was based on the philosophy of "use as many subjects as you can get and you can afford" [19]. Moreover, Fellows and Liu [20], suggest that "large number" statistics require a sample size equal to or greater than 32. The sample size is also comparable to similar studies as presented in previous sections.

3.3. Stage 3: Analysis of Results

To test the reliability of the questionnaire, the standardized Cronbach's alpha (α) test was employed. In general, a range of (0.7 to 1.0) may be considered satisfactory [21]. Higher values denote greater internal consistency and vice versa. Mathematically, α is calculated as follows:

$$\alpha = \frac{K\hat{r}}{(1+(K-1)\hat{r})} \tag{1}$$

Where K is the number of components in the test; and $\hat{r}$ is the mean of the triangular correlation matrix. Doloi [22] provides the following scale as a rule of thumb: $\alpha > 0.9$ denotes excellent, $0.9 > \alpha > 0.8$ as good, $0.8 > \alpha > 0.7$ as acceptable, $0.7 > \alpha > 0.6$ as questionable, $0.6 > \alpha > 0.5$ as poor and $0.5 > \alpha$ denotes unacceptable.

Data analysis of the retrieved questionnaire survey was made using the Relative Importance Index approach similar to previous studies. The use of the RII methodology in this research was to identify and rank the most important causes of delay. The RII also promotes the possibility for comparison of the results from various studies. Moreover, researchers are of the opinion that the mean and standard deviation of each individual attribute is not a suitable measure [22], [23]. The RII calculation considered in this study is presented as follows [3]:

$$\text{RII} = \frac{\sum_{i=0}^{n}(a_i)(x_i)}{n\sum x_i} \tag{2}$$

Where a_i is the constant representing the weight assigned to i (ranges from 1 to n); and x_i is the variable representing the frequency assigned to i (ranges from 1 to n).

To determine the level of agreement between various respondent categories, Spearman's rank correlation coefficient (r_s) was employed in conformance with previous studies [23]. The rank of various causes of delay according to the Consultants (Architecture/Structure/MEP/PM), Contractors, and

Clients' Representatives/Facility Managers was determined and utilized as inputs. Mathematically, Spearman's rank correlation coefficient (r_s) is calculated as follows:

$$r_s = 1 - \frac{6\sum d^2}{n(n^2-1)} \quad (3)$$

Where d is the difference between the ranks indicated by two respondent groups, and n is the number of records. The value of the Spearman rank correlation coefficient ranges from +1 (perfect correlation), to 0 (no correlation), to −1 (perfect negative correlation).

4. RESULTS AND FINDINGS

4.1 Respondents profile and questionnaire's reliability

The demographic information of the respondents in this study is presented in figure 1, respondents were composed mainly of senior professionals in three categories (consultants, contractors and client representatives/facility managers) practicing in the GCC countries. Respondents in the GCC (i.e. Saudi Arabia, United Arab Emirates, Kuwait, Bahrain, Oman and Qatar) were contacted through professional bodies, personal emails, as well hand delivered questionnaire surveys to tall building construction sites. A total of 62 responses were received, while 5 responses were discarded as unusable, due to being improperly filled or coming from professionals outside the GCC. Thus, a total of 57 responses were used in this study. The quality of the response in exemplified in the fact that only senior professionals in the organizations contacted provided were requested to provide their feedback. To test the reliability and consistency of the questionnaire survey, Cronbach's alpha was calculated to be 0.99, indicating an excellent reliability of the questionnaire survey. As shown in figure 1, the contractors represent 30% of the population, while the consultants represent 35%, and similarly the clients' representatives/facility managers. The figure also shows that 23% of the respondents were designated as project managers at the time of the survey, while 21% were holding facility manager roles, 15% director roles and 11% executive director roles. Majority of the respondents, representing 48%, had greater than 15 years of experience in tall building projects. UAE and Saudi Arabia, with 42% and 33%, represents the majority in terms of the location of the respondents. Feedback from the respondents showed that their professional experience spans various types of tall building projects including residential, commercial, hotels, multi-use as well as other types of facilities.

4.2 Relative Importance Index and ranking of delay causes

As established previously, the RII approach is the most popular method used in studies on the causes of construction delays. In this study, the RII values have been presented according to three professional categories including the consultants, contractors and clients' representative/facility managers. Additionally, the overall RII value combining the three professional categories are also presented as shown in table 1. Table 1 also presents the RII values and rankings for the 9 groups. It can be seen from table 1 that the top five causes of delays in tall building projects include: Fin. 2: "client's cash flow problems/delays in contractor's payment"; Fin. 1: "contractor's financial difficulties"; Sch. 1: "poor site organization and coordination between various parties"; Cont. 1: "inappropriate construction/contractual management/construction methods"; and Sch. 7: "poor qualification of the contractor or consultant". Similarly, the last 5 causes in ascending order include: Env. 2: "civil disturbances/hostile political conditions"; Env. 1: "weather condition"; Man. 3: "labor disputes and strikes"; Mat. 1: "shortage in construction materials/unforeseen material damages"; and Chng. 4: "unexpected foundation conditions encountered in the field". The table also shows that the most significant group of delay causes is the "causes related to financing" group, with an RII value of 0.82.

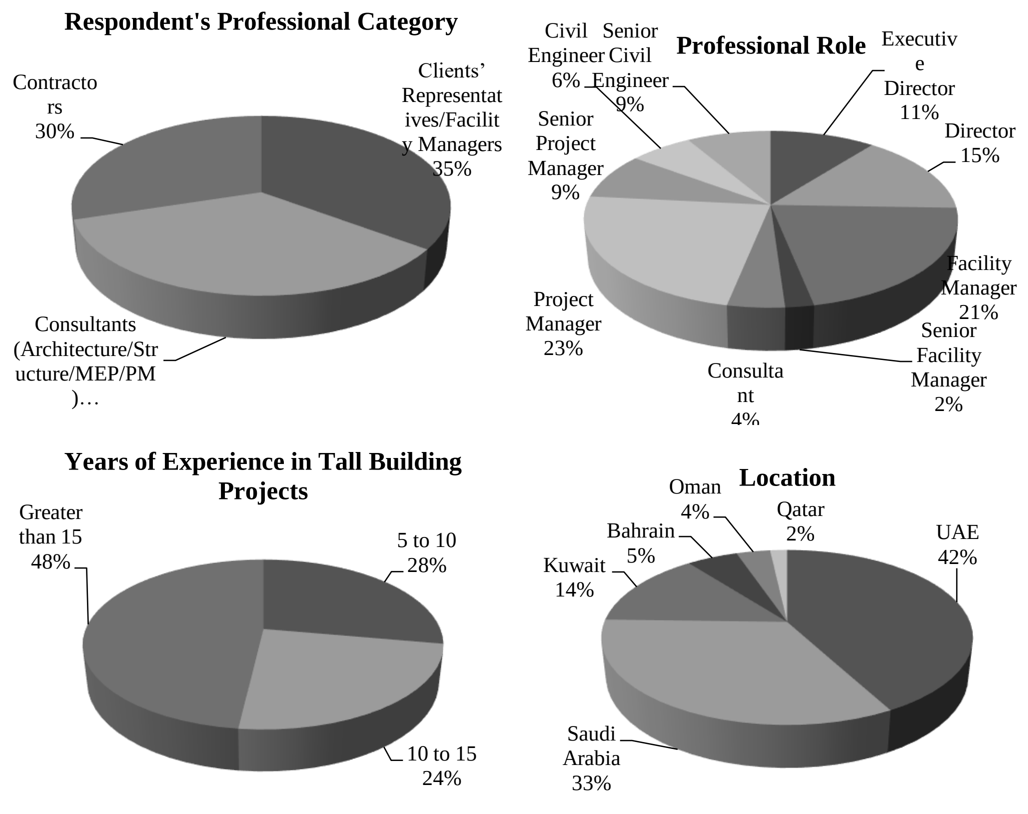

Figure 1. Demographic information of respondents

Table 1. Relative Importance Index and ranking of the causes of delay

S/N	Causes of delay		Consultants		Contractors		Clients' Representatives/Facility Managers		Total	
			RII	Rank	RII	Rank	RII	Rank	RII	Rank
Causes related to material			**0.68**	**7**	**0.8**	**3**	**0.75**	**4**	**0.74**	**5**
1	Mat. 1	Shortage in construction materials/unforeseen material damages	0.67	31	0.77	14	0.7	27	0.71	32
2	Mat. 2	Slow delivery of materials	0.71	27	0.86	3	0.74	18	0.76	18
3	Mat. 3	Waiting for approval of shop drawings and material samples	0.67	31	0.77	14	0.8	8	0.75	21
Causes related to manpower			**0.75**	**5**	**0.69**	**8**	**0.74**	**5**	**0.73**	**6**
4	Man. 1	Shortage in manpower (skilled, semi-skilled, unskilled labor)	0.81	9	0.77	14	0.74	18	0.77	13
5	Man. 2	Poor labor productivity	0.8	13	0.71	31	0.79	14	0.77	14
6	Man. 3	Labor disputes and strikes	0.64	34	0.6	35	0.69	30	0.65	34
Causes related to equipment			**0.72**	**6**	**0.72**	**7**	**0.74**	**5**	**0.73**	**6**
7	Equip. 1	Poor equipment productivity (breakdown/maintenance problem)	0.71	27	0.73	27	0.74	18	0.73	27

8	Equip. 2	Shortage in equipment	0.73	23	0.7	33	0.74	18	0.72	28
Causes related to contractual relations			**0.79**	**2**	**0.78**	**4**	**0.78**	**2**	**0.78**	**2**
9	Cont. 1	Inappropriate construction/contractual management/ construction methods	0.83	5	0.83	6	0.83	5	0.83	4
10	Cont. 2	Slowness in decision making	0.84	3	0.8	9	0.73	22	0.79	12
11	Cont. 3	Delay in mobilization	0.67	33	0.73	27	0.76	16	0.72	30
12	Cont. 4	Excessive bureaucracy/interference by the owner	0.82	7	0.79	10	0.72	23	0.77	14
13	Cont. 5	Delay in approval of completed work	0.73	22	0.78	11	0.8	8	0.77	16
14	Cont. 6	Delay in sub-contractors work	0.83	4	0.76	18	0.81	6	0.81	8
Causes related to government			**0.79**	**2**	**0.81**	**2**	**0.76**	**3**	**0.78**	**2**
15	Gov. 1	Slow permits from municipality/government	0.81	11	0.83	5	0.8	8	0.81	7
16	Gov. 2	Government regulations	0.77	19	0.78	12	0.71	24	0.75	19
Causes related to financing			**0.81**	**1**	**0.84**	**1**	**0.83**	**1**	**0.82**	**1**
17	Fin. 1	Contractor's financial difficulties	0.81	11	0.85	4	0.9	1	0.85	2
18	Fin. 2	Client's cash flow problems/Delays in contractor's payment	0.9	1	0.89	1	0.88	3	0.89	1
19	Fin. 3	Price escalation/fluctuations	0.72	24	0.78	12	0.7	27	0.73	26
Causes related to environmental factors			**0.59**	**8**	**0.63**	**9**	**0.59**	**7**	**0.59**	**7**
20	Env. 1	Weather condition	0.58	36	0.65	34	0.59	35	0.6	35
21	Env. 2	Civil disturbances/Hostile political conditions	0.61	35	0.6	35	0.58	36	0.59	36
Causes related to changes			**0.77**	**4**	**0.77**	**5**	**0.73**	**6**	**0.76**	**4**
22	Chng. 1	Design errors/incomplete made by designers (Architects and structural drawing)	0.82	8	0.86	2	0.75	17	0.80	9
23	Chng. 2	Design variations/change orders/increase in scope of work	0.83	6	0.83	6	0.8	8	0.82	6
24	Chng. 3	Errors committed due to lack of experience	0.79	15	0.75	19	0.81	6	0.79	11
25	Chng. 4	Unexpected foundation conditions encountered in the field	0.71	27	0.74	25	0.69	31	0.71	32
26	Chng. 5	Changes in materials types and specifications during construction	0.78	18	0.74	25	0.69	31	0.74	23
27	Chng. 6	Inaccurate site/soil investigation	0.72	24	0.75	19	0.68	34	0.71	31
28	Chng. 7	Frequent change of sub-contractor	0.75	21	0.75	19	0.69	31	0.73	25
Causes related to scheduling and controlling techniques			**0.78**	**3**	**0.75**	**6**	**0.78**	**2**	**0.77**	**3**
29	Sch. 1	Poor site organization and coordination between various parties	0.87	2	0.75	19	0.89	2	0.85	3

30	Sch. 2	Poor planning of resources and duration estimation/scheduling	0.81	9	0.77	17	0.8	8	0.79	10
31	Sch. 3	Inadequate supervision, inspection and testing procedures	0.79	16	0.71	32	0.78	15	0.76	17
32	Sch. 4	Accidents during construction/lack of safety measures	0.68	30	0.72	29	0.8	8	0.74	22
33	Sch. 5	Poor communication/documentation and detailed procedures	0.77	20	0.72	29	0.71	24	0.73	24
34	Sch. 6	Unrealistic time schedule imposed in contract	0.8	13	0.75	19	0.7	27	0.75	19
35	Sch. 7	Poor qualification of the contractor or consultant	0.79	16	0.83	6	0.86	4	0.83	5
36	Sch. 8	Architects'/structural engineers' late issuance of instruction	0.72	26	0.75	19	0.71	24	0.72	29

4.3 Test of Agreement between Various Groups

The Spearman rank correlation coefficient has been used by other similar studies to test the level of agreement between parties and groups of respondents. In this study, the correlation between consultants and contractors, consultants and client's representatives/facility managers, and contractors and client's representatives/facility managers were 0.58, 0.55 and 0.47 respectively. These results indicate a moderate level of agreement between all parties. More specifically, the contractors and client's representatives/facility managers had the least level of agreement. This may be attributed to widely opposing views between both parties during the project life cycle, and especially during the testing and commissioning process which delays handover of the project to the client's representatives/facility managers.

4.4 Open-ended response on the questionnaire survey

The open ended section of the questionnaire survey was used to derive more qualitative feedback from respondents on the causes of delay. The crucial areas leading to delays may be summarized as follows:

- Poor project management and dispute resolution skills.
- Increasing complexity in tall building designs.
- Lack of engagement with the supply chain early in the process.
- Poor contract administration and contractor selection process.
- Poor technical capabilities of the clients' representatives.
- Redesign and rework due to poor coordination of MEP systems with other systems.
- Delay in handover process due to lack of involvement of the end-use/facility manager from the project inception stage.
- Lack of competence critical to technologies in modern projects such as digital twin.
- Preference for imported materials-which are delivered late-over locally available materials.
- Change in key client personnel.
- Major changes in the use, shape or facade of buildings requiring re-design/checking already constructed elements.

5. DISCUSSION

The construction industry for many decades has been plagued with inefficiency and productivity losses, amongst which are incessant delays in large building projects. Therefore, the research domain features an abundant amount of literature in identifying the causes of construction delays. These studies can be classified as either country/location specific or project specific [3]. Though, such construction delay studies are exploratory in nature and do not provide the ultimate solution needed by the industry [1], experts are of the opinion that identifying the causes of delay is the first step in developing effective solutions to mitigate them. Despite the huge amount of work that predominate, not much attention has been accorded to delays that occur in tall building projects. The significance, of tall buildings in the urban context is in its potential to be a viable solution to an impeding housing crisis. Interestingly, these buildings have been subject to incessant delays and total abandonment, and thus defeating their objective as a sustainable solution. Notably, CTBUH outcries the increasing rate of tall building abandonment, while providing a list of 50 projects of 150m or taller that were never completed [2].

This study thus explores the causes of delay in tall building projects, using countries in the Gulf Cooperation Council as a case study. Firstly, 36 major causes of delay were identified from influential studies carried out across the globe [3]. These causes were further assessed by senior level construction professionals in the GCC countries. The results showed that the most significant cause of delay was related to financial issues which conforms to the global trend on delay causes. Tall buildings are viewed as risky investments, and thus, suffer from cost overruns, time overruns and ultimately abandonment of the project. This study also showed that delay causes such as “weather condition” may be prevalent in other countries such as Singapore [9], it is perceived as not contributing to significant delay in the GCC region. This may be largely due to the arid nature of the region, where rainfall occurs few times in the year. Likewise, delay causes such as “civil disturbances/hostile political conditions”, “labor disputes and strikes”, “shortage in construction materials/unforeseen material damages”; and “unexpected foundation conditions encountered in the field” were perceived as the least causes contributing to details. Further qualitative feedback from the respondents hinted that tall building projects are subjected to extensive soil and foundation studies such that “unexpected foundation conditions encountered in the field” is unacceptable, and usually does not occur. This study also shows how the causes of delay in tall building projects may vary with respect to the construction climate under investigation. Significant implications for research and practice may be derived from this study. For professional practice, it could form the basis for developing guidelines and recommendations, as well as project control and monitoring strategies for tall building projects. Furthermore, real estate investors could use the causes of delay identified in financial risk assessments in project feasibility studies. As for the research implications, it would be interesting to see how the results of this study will compare to further studies from China and the USA, where there has been rapid development of tall buildings in the past few decades.

5. CONCLUSION

The proliferation of tall building structures in urban centers across the globe is sufficient evidence that the urban built environment is witnessing a paradigm shift centered on sustainability and efficiency. This building type however suffers from delays and total abandonment. Thus, this study sought to investigate the causes of delay in tall building projects in the GCC countries. The results showed that the top three causes of delay include “client’s cash flow problems/delays in contractor’s payment”; “contractor’s financial difficulties”; and “poor site organization and coordination between various parties”, while the most significant group causing delay is the “causes related to financing” group. Notably, the study revealed that delay causes such as “civil disturbances/hostile political conditions” and “labor disputes and strikes” were perceived as relatively insignificant in the GCC countries. Furthermore, “unexpected foundation conditions encountered in the field” was considered as an unlikely cause of delay in tall building projects, as soil and foundation investigations are considered critical aspects of tall building projects. The contribution of this study is in the assessment of major delay causes in tall building projects, a fast rising construction phenomenon in the 21st century. Understanding the causes of delay is recognized as the first step towards mitigation and control. It is hoped that the results of this study will be carried over to professional practice in delay risk mitigation, as well as further research in other construction climates.

ACKNOWLEGEMENTS

The authors are thankful to all professionals that participated in the questionnaire survey, and give special thanks to the Middle East Facility Management Association (MEFMA) for helping in the data collection process.

REFERENCES

[1] M. Sanni-Anibire, R. Zin, and S. Olatunji, “Machine learning model for delay risk assessment in tall building projects,” *International Journal of Construction Management,* pp. 1–10, May 2020.

[2] CTBUH “Dream Deffered: Unfinished Tall Buildings,” CTBUH Journal, Issue 4, 2014.

[3] M. Sanni-Anibire, R. Zin, and S. Olatunji, “Causes of delay in the global construction industry: a meta analytical review,” *International Journal of Construction Management*, 2020.

[4] S. Ogunlana, K. Promkuntong, and V. Jearkjirm, “Construction delays in a fast-growing economy: comparing Thailand with other economies,” *International journal of project Management,* vol. 14, no. 1, pp. 37-45, 1996.

[5] P. Kaming, P. Olomolaiye, G. Holt, and F. Harris, “Factors influencing construction time and cost overruns on high-rise projects in Indonesia,” *Construction Management and Economics,* vol. 15, no. 1, pp. 83–94, Jan. 1997.

[6] S. Suksai, W. Moungnoi, S. Charoenpornpattana, and S. Homthong, “Delay Factors between Main Contractors and Nominated Subcontractors in High Rise Buildings in Thailand,” *GSTF Journal of Engineering Technology,* vol. 3, no. 3, 2015.

[7] P. Bhangale, “Investigation of Causes of Delay in High Rise Building Project and Remedial Measures Case Study-Pune,” *International Journal of Engineering Research and Applications,* vol. 7, no. 7, pp. 72–77, 2017.

[8] A. Haslinda, T. Xian, K. Norfarahayu, R. Hanafi, and H. Fikri, “Investigation on the Factors Influencing Construction Time and Cost Overrun for High-Rise Building Projects in Penang,” *In Journal of Physics: Conference Series,* vol. 995, no. 1, p. 012043, 2018.

[9] Y. Kog, “Project management and delay factors of public housing construction,” *Practice Periodical on Structural Design and Construction*, vol. 23, no. 1, pp. 04017028, 2017.

[10] P. Aaditya and S. Bhattacharya, "A study of the Causes of Schedule overrun in Indian High-rise construction using Relative Importance Index", *In GSTF Journal of Engineering Technology (JET),* vol. 5, no. 1, 2018.

[11] Y. Abdelhadi, M. Dulaimi, and A. Bajracharya, “Factors influencing the selection of delay analysis methods in construction projects in UAE,” *International Journal of Construction Management*, pp. 1–12, Feb. 2018.

[12] M. Chew, "Construction Technology for Tall Buildings". World scientific, 2017.

[13] UN, “World Population Prospects The 2015 Revision,” 2015.

[14] B. Yuen, A. Yeh, S. Appold, G. Earl, J. Ting, and L. Kwee, “High-rise Living in Singapore Public Housing,” *Urban Studies,* vol. 43, no. 3, pp. 583-600, 2006.

[15] P. Newman, “Sustainability and Cities: The Role of Tall Buildings in this New Global Agenda,” *Tall Buildings and Urban Habitat,* (903), 75, 2001.

[16] M. Ali and K. Al-Kodmany, “Tall Buildings and Urban Habitat of the 21st Century: A Global Perspective,” *Buildings,* vol. 2, no. 4, pp. 384–423, 2012.

[17] A. Aibinu and G. Jagboro, “The effects of construction delays on project delivery in Nigerian construction industry,” *International Journal of Project Management,* vol. 20, no. 8, pp. 593–599, Nov. 2002.

[18] P. Kaming, P. Olomolaiye, G. Holt, and F. Harris, “Factors influencing construction time and cost overruns on high-rise projects in Indonesia,” *Construction Management and Economics*, vol. 15, no. 1, pp. 83–94, Jan. 1997.

[19] S. Olejnik, “Planning educational research: Determining the necessary sample size,” *The Journal of Experimental Education,* vol. 53, no. 1, pp. 40-48, 1984.

[20] R. Fellows and A. Liu, “Research Methods for Construction,” *John Wiley & Sons,* 2015.

[21] J. Yang and S. Ou, “Using structural equation modeling to analyze relationships among key causes of delay in construction,” *Canadian Journal of Civil Engineering,* vol. 35, no. 4, pp. 321–332, Apr. 2008.

[22] H. Doloi, A. Sawhney, K. Iyer, and S. Rentala, “Analysing factors affecting delays in Indian construction projects,” *International Journal of Project Management*, vol. 30, no. 4, pp. 479–489, May 2012.