



Identification of Delay Factor in Oman Construction Industry

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Abstract: Construction industry is second most significant and largest industry in gulf countries that continuously and rapidly growing. However the decline in economies of gulf countries due to fluctuated oil has ambiguous effect on the construction industry. Like other countries around the world, construction industries in gulf region also facing many problems and amongst the most common problem is delay/time overrun. This paper aims to identify various factors in construction management which causing delay in construction projects at Muscat, Khabourah, Bidbid, Musanah and Sohar cities in OMAN. Fourty eight (48) delay factors identified from literature around the world and organized in structured questionnaire survey form. Delay factors were categorized into five major groups in construction process which are Planning, Design, Construction, Finishing, and Miscellaneous. The forms were distributed amongst the construction experts focusing clients, consultants and contractors involved in the construction projects. A total of 105 collected data were analyzed by using Average Index method for each factor. Furthermore, delay causing factors analyzed by individual response of client, consultant and contractor prospective. The analysis identified that '*changes in scope of project*', '*lack of communication between parties*', '*shortage of skilled labour*', '*mistakes during construction*', and '*insufficient data collection and survey before designing*'; are the most significant causes in each category respectively. The result of this study is useful to create or/and improve guideline considering delay, to avoid problems in looming construction.

Keywords: delay, time overrun, construction, causes, factors, management, Muscat, Oman

1. Introduction

Construction industry's main objective is to assure that the projects finish on time, and achieve other goals. Project completion time, is indispensable concerns in construction management, and envisioned as most important restrictions for measuring success of any construction project. Delay can be defined as late completion of works as compared to the planned schedule or contract schedule (Assaf & Al-Hejji, 2006, Aftab *et al.*, 2014, Aftab *et al.*, 2011 and Nuaimi & Mohsin, 2013). The time overrun of construction project for any reasons causes extension of time for completion of project (Assaf & Al-Hejji, 2006, Aftab *et al.*, 2014, Aftab *et al.*, 2011 and Nuaimi & Mohsin, 2013). This time overrun leads to cost overrun, which requires additional fiscal costs in order to complete projects (Assaf & Al-Hejji, 2006, Aftab *et al.*, 2014, Aftab *et al.*, 2011 and Nuaimi & Mohsin, 2013). Many countries around the world facing time overrun problem. The basic root causes of time over are deficit in construction management (Assaf & Al-Hejji, 2006,

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Aftab *et al.*, 2014, Aftab *et al.*, 2011 and Nuaimi & Mohsin, 2013). This paper aims to identify various factors causing time overrun in construction projects at Muscat, Khabourah, Bidbid, Musanah and Sohar cities in OMAN at different stages of construction of project such as Planning, Design, Construction, Finishing, and Miscellaneous. The findings will help construction industry to avoid and reduce the time overrun in future projects.

2. Literature on Time Overrun in Gulf Region

Several studies around the world have been conducted in order to understanding what are the laps causing time overrun of projects. Aziz (2013) studied 99 delay factors summarized in 9 construction categories by using relative importance index (RII) in construction projects after Egyptian revolution in 2013, Aziz found 27 significant factors in nine categories (Aziz, 2013). Marzouk and El Rasas in 2014 studied construction delay in Egypt considering owners, consultants, and contractors as respondent. Significant causes for time overrun in Egypt are ineffective planning and scheduling of project, difficulties in financing project by contractor, variation orders/changes of scope, poor site management and supervision, type of project bidding and award, low productivity level of labors, effects of subsurface conditions, unqualified workforce, shortage of construction materials in market, and delays in sub-contractors work, mistakes and discrepancies in design documents (Marzouk & El-Rasas, 2014). Ghanim (2015) studied delay factors in Iraq and found most significant causes are low performance of the lowest bidder contractors in the Iraqi government tendering system, Design changes, Delay in progress payments, Mistakes in soil investigation, Cash flow problems, Deficiency in drawings (Bekr, 2015). In 2015, Nashwan and Sasitharan, studied delay factors in at Mecca Kingdom of Saudi Arabia considering construction experts prospective. They selected 81 delay factors from literature review and interviewed 28 construction experts. Questionnaire data were analysed by using Average Index method. The results shows that the most six significant factors were Changes in design documents, Low productivity level of labour, Shortage of manpower, Difficulties in financing project by contractor, Poor contract management, and Unqualified workforce (Nashwan & Sasitharan, 2015). In 2017, Nabil *et al.*, analyses delay factor at Amman, Jordan on 40 public infrastructure projects completed during 2000 to 2008. The results show that the most critical factors are: Terrain conditions, weather conditions, variation orders, and unavailability of labors . In UAE construction industry contributes 14% to GDP. Faridi and El Sayegh (2007) studied factor causing delay in UAE construction industry by using Relative Importance Index (RII) method. The results shows that 50% of construction projects in UAE in-complete on schedule, among top 10 factors, Approval of drawings, inadequate early planning, and slowness of the owners' decision making is top 3 significant causes (Faridi & El Sayegh, 2007). Gundaz & Abu Hasan (2016) studied causes of delay considering infrastructure, superstructure, at oil gas industry of QATAR, by using relative importance index, and frequency index. They found higher relative index for Delay in decision making, Poor site management and supervision, shortage of construction material, and high frequency index for Low productivity of labour, Delay related to sub-contractor work, Changes to the project by owners (Gundaz & Abu Hasan, 2016).

Like other countries in Gulf region, construction industry in Oman is also facing a lot of challenges considering delay almost in all mega construction projects. For example expansion of Muscat International Airport, Salalah Airport, Ministry of Education building in Muscat etc. Al Nuaimi & Al Mohsin (2013) studied delay in construction project at Muscat Oman for year 2007 to 2008 and 2009 to 2010. They found 40% of projects faced delay in completion. For projects of 2007 to 2008 most significant causes were Weather, Variations and claims, Changes in initial design etc. For projects of 2009-2010 they found Planning and programming construction work, Poor construction experience, shortage in material causes delay (Nuaimi & Mohsin, 2013). Oyegoke and Al Kiyumi (2017) studied delay and mitigation factors, 53 questionnaire analyzed by using relative importance index, they found most significant causes of delay are selection of the lowest bid, the financial condition of the main contractor, delay in decision-making by the client, poor construction planning by the main contractor. Mitigation factors are the use of experienced contractors and consultant, efficient construction planning by the main contractor, and effective site management and supervision (Oyegoke & Al Kiyumi, 2017). Al Amri *et al.* (2017), studied delay causes in dam construction projects. 60 factors under 4 categories Client, Consultant, Contractor, and External factors were collected from literature and analysed statistically based on importance index, frequency index and severity index. Based on Pareto's law of 80/20, they found most significant causes are severe weather conditions, change orders, uncertainty in ground condition, poor site management, executive bureaucracy in client organization, feasibility study did not cover all aspects, mistakes in soil investigation, natural effects during construction work, difficulty of defining project requirement, slowness of decision making process, delay of obtaining approval from the different government authorities, and land acquisition (Al Amri *et al.*, 2017). Umar (2018) studied delay factor in construction industry of Oman, Umar found that contractual issues, workforce, materials, coordination between construction parties, and external factors are the main factors which cause delay to construction projects in Oman (Umar, 2018).

3. Methodology

In this study, quantitative method via structured questionnaire was implemented to evaluate the construction professional's perceptions about flaws in management, those can contribute in delay. This survey designed in accordance collection of data from relevant literature about causes of delay. A questionnaire were distributed to find

out what construction industry experts (client, consultant, contractor) knows and what is important issues considering delay. This survey was conducted based on convenience sampling technique (Aftab *et al.*, 2014, Aftab *et al.*, 2011 and Nashwan & Sasitharan, 2015). The collected data were analysed by using Average Index method to get most significant causes of delay. In the end recommendation based on construction industry professionals are suggested to overcome delay problems in future construction.

3.1 Structure of Questionnaire

Questionnaire is divided into three parts: Demographics, factors causing time overrun suggestions and recommendations. In first part, basic details of respondents (Nashwan & Sasitharan, 2015), in second part, causes of time overrun based on literature studies mentioned, and in third part, respondent suggestions and recommendations regarding reduction of delay in construction project.

3.2 Data Sources

The questionnaire also was used to collect detailed information about respondent's organization, experience and impressions regarding material waste. Data was collected from two resources. Primary source of data collection was by the elects through the use of questionnaires, and site visits (observation). The secondary sources of data were obtained using the research papers. Fourty eight (48) factors causing time overrun have been extensively studied and extracted under construction project sources such as planning phase, designing phase, construction phase, finishing phase, and miscellaneous from the literature (Nabil *et al.*, 2017).

3.3 Data Collection

The questionnaire survey was carried out by distributing a total of 150 questionnaire sets, among 150 questionnaires 135 were received as data collection. It was found that 30 of returned questionnaires were having error considered unacceptable, and excluded from data analysis. The collected data of 105 respondents used in analysis.

3.4 Average Index Method for Analysis

The questions were constructed using the Likert scale. The respondents were asked to rank on a scale of 1-5 factors that cause delay and cost overrun where 1 = "Not Important", 2 = "Least Important", 3 = "Important", 4 = "Very Important" and 5 = "Most Important" (Nashwan & Sasitharan, 2015). The significant of the factors are determined by Rating & Ranking Average Calculations. Rating Scale questions calculate a weighted average based on the weight assigned to each answer choice. The rating average is calculated as follows (Nashwan & Sasitharan, 2015):

$$\text{Average Index (AI)} = \frac{W_1 X_1 + W_2 X_2 + W_3 X_3 + W_4 X_4 + W_5 X_5}{N} \quad (1)$$

where,

N= Total number of respondents,

$W_1 = 1$ for "Not Important"

$W_2 = 2$ for "Least important"

$W_3 = 3$ for "Important"

$W_4 = 4$ for "Very Important"

$W_5 = 5$ for "Most Important"

$X_1 =$ No. of respondents of W_1

$X_2 =$ No. of respondents for W_2

$X_3 =$ No. of respondents for W_3

$X_4 =$ No. of respondents for W_4

$X_5 =$ No. of respondents for W_5

4. Demography of Respondent

The demography of this survey is the respondents of contractors, consultants and clients. Fig. 1 shows the education level, experience and background of the respondents. It was found that the majority of the respondents are in the contractor's field, 47%, followed by consultant, 33% then client having 20%. In term of experience in the

construction industry, 60% of respondents had working experience of 0 to 10 years, followed by 27% respondents who possessed working experience of between 11 to 20 years, and 13% of respondents had working experience of 21 to 30 years. The minority group of respondents in terms of work experiences was those between 21 to 30 years experiences is 13%. Furthermore, Its show that the highest qualification of the respondents is Bachelor's degree having 73%, followed by Master's degree having 14%, then Diploma certification having 13%.

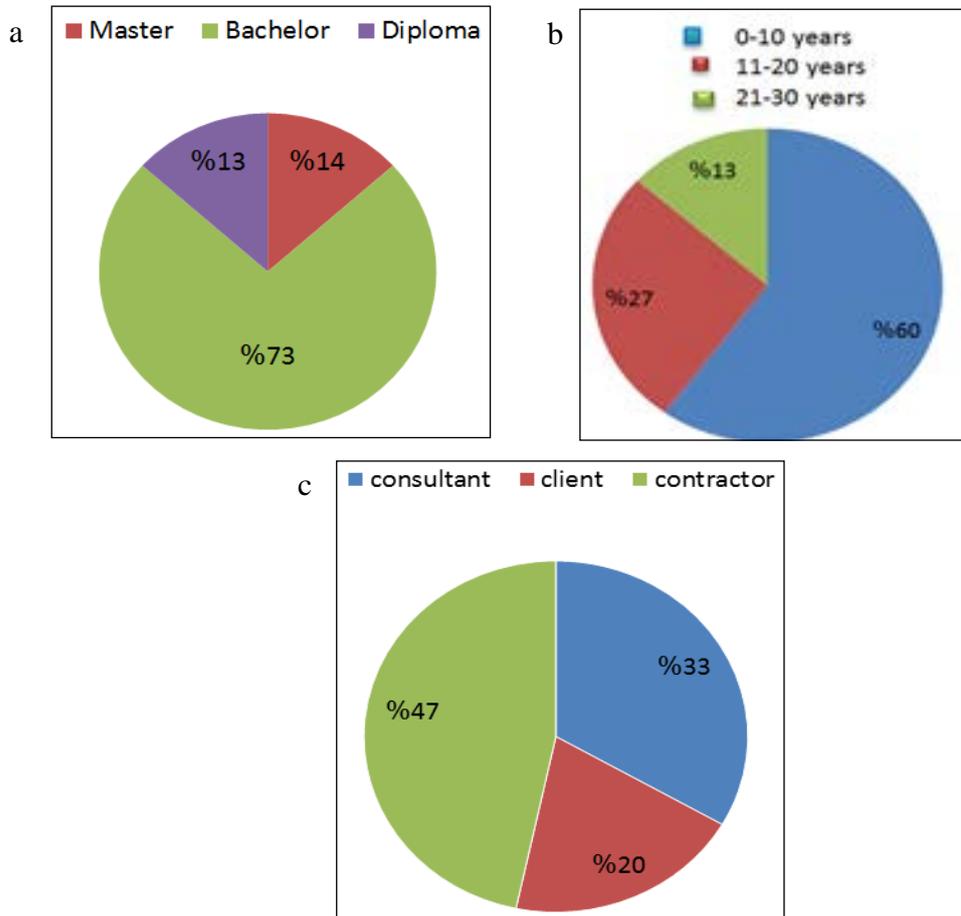


Fig. 1 - (a) The qualification of respondents; (b) The experience of respondents; (c) The organization of respondents

5. Significant Causes of Time Overrun

5.1 Planning Phase

In this category, four significant factors considered that contribute in causing delay in construction project. Fig. 2 showing the frequency of respondents. Fig. 3 shows the average index analysis of time overrun significant causes in planning phase considering all responses of client, contractor and consultant. ‘Change in scope of project’ ranked on top with average index value of 4.10, ‘Slow information between parties’ is considered as second significant cause with index value 3.90, and ‘Frequent design changes’ is considered as third most significant cause of time overrun in construction projects with average index score of 3.87.

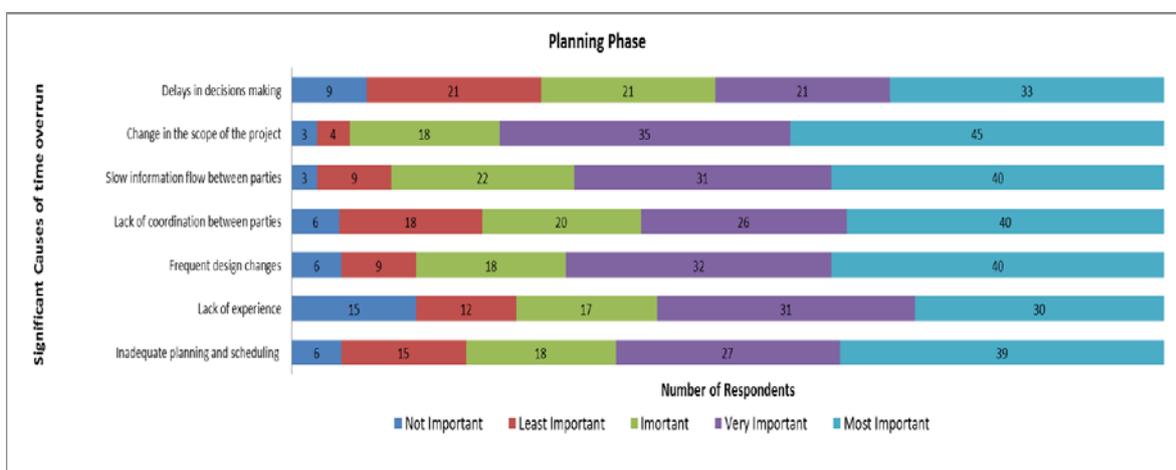


Fig. 2 - Distribution of response in planning phase

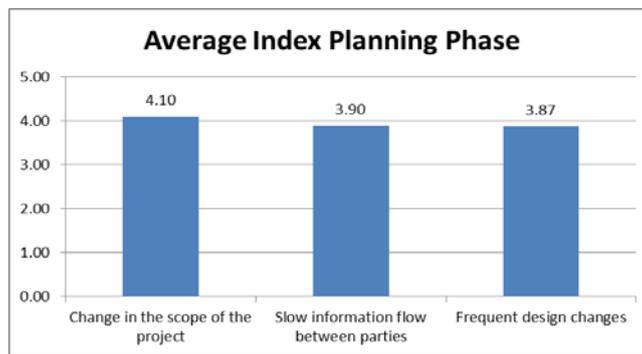


Fig. 3 - Ranking of factors causing time overrun in planning phase

Table 1 - Client, consultant and contractor’s prospective in planning phase

Category	Respondents	Most significant factors
Planning	Client	Lack of experience Inadequate planning and scheduling
	Consultant	Change in the scope of the project Frequent design changes
	Contractor	Slow information flow between parties Frequent design changes

Table 1 shows two most significant causes of time overrun in construction projects considering client, consultant, and contractor prospective. In planning phase results from client, consultant and contractors gives idea that all those factors are inter-related with each other. Based on client prospective it is revealed that ‘Inadequate planning and scheduling by consultant’ and ‘lack of experience (less number and less skilled professional hired for jobs) are main causes of time overrun in construction industry. However, based on consultant, changes as per will of client and late decision making leads to the ‘Change in the scope of the project’, and ‘frequent design changes’. According to contractor vast lack of communication between client and consultant, and contractor causes ‘slowing information flow between parties’, and lack of detailed feasible study before staring project, feasibility studies carried by ignoring unforeseen conditions at site cause 'Frequent design changes'.

5.2 Design Phase

Fig. 4 shows frequency of responses in design phase of construction management. Fig. 5 comprises three significant factors considered based average index method where 'lack of communication between parties ranked as 1st with AI score of 3.99, 'Incomplete design at time of tender is considered as 2nd most significant cause with AI of 3.89, and 'Poor design and delay in designing' ranked as third with AI 3.75.

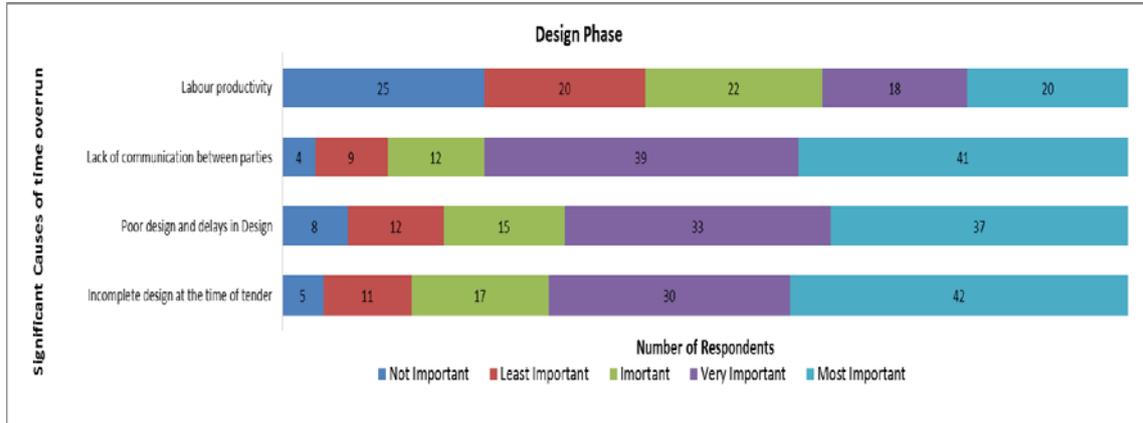


Fig. 4 - Distribution of response in design phase

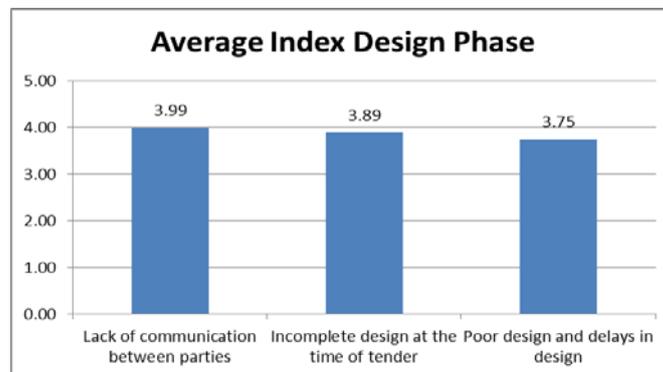


Fig. 5 - Ranking of factors causing time overrun in design phase

Table 2 - Client, consultant and contractor’s prospective in design phase

Category	Respondents	Most Significant Factors
Designing	Client	Incomplete design at the time of tender Lack of communication between parties
	Consultant	Lack of communication between parties
	Contractor	Incomplete design at the time of tender Poor design and delay in designs

Table 2 showing the result of factors causing delay in design phase considering owner, consultant, and contractor prospective. In design phase based on client 'incomplete design at the time of tender' and 'Lack of communication between parties' are considered as main causes of delay in projects. However consultant response is 'Lack of communication between parties'. According to contractor 'Incomplete design at the time of tender' and 'poor design and

delays in design' are considered as main causes of delay in construction projects. It is noted that incomplete design at the time of tender is related with poor design and delay in designing, as incomplete information at time of tender is main reason of revised designing which certainly gives impression of poor designing and delay in designing of construction projects. However 'lack of communication between parties' and in appropriate time frame of tender and feasibility study' leads to 'incomplete design at time of tender'.

5.3 Construction Phase

Construction involves the biggest number of contributory factors that are 23 factors which contributes in causing delay of the project. Fig. 6 shows frequency of responses in construction phase for only significant causes of time overrun in construction projects. Fig. 7 shows the highest ranked cause in construction phase is 'Shortage of technical personal (skilled labor) with AI score of 3.9, second 'Incompetent sub-contractors' with AI of 3.83, followed by 'Mistakes and errors in design' and 'financial difficulties of owners' with AI of 3.82, than 'Delay in preparation and approval of drawings' with score of 3.78, and last is 'In-complete designing at time of tender' with score of 3.72.

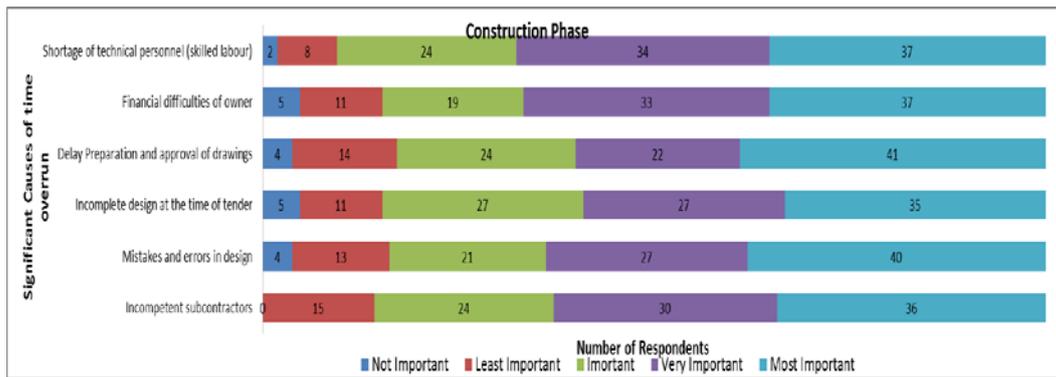


Fig. 6 - Distribution of response in construction phase

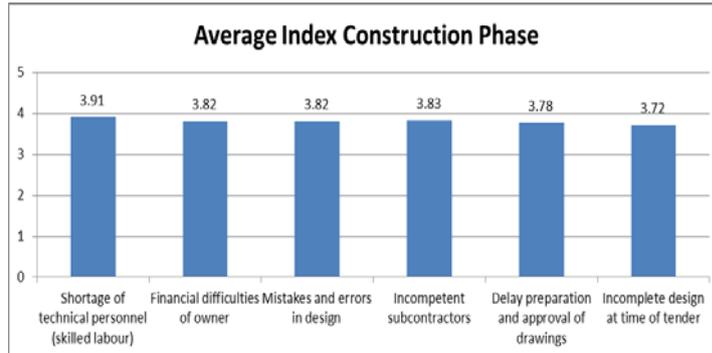


Fig. 7 - Ranking of factors causing time overrun in cconstruction phase

Table 3 - Client, consultant and contractor's prospective in construction phase

Category	Respondents	Most significant factors
Construction	Client	Incomplete design at time of tender Shortage of technical personnel (Skilled labour)
	Consultant	Financial difficulties of owner Incompetent subcontractor
	Contractor	Mistakes and errors in design Delay in preparation and approval of drawings

Table 3 in construction phase based on client 'Incomplete design at time of tender' and 'Shortage of technical personnel (skilled labour)' are considered as main causes of delay in projects. However consultant response is 'financial difficulties of owners' and 'Incompetent subcontractors' are causing delay in construction projects. According to contractor ' Mistakes in design' and 'Delay in preparation and approval of drawings' are considered as main causes of delay in construction projects. Now-a-days financial crisis around all over the world effecting construction development and growth of countries. Due to oil prices instability, financial crisis and shortfalls all contributors of construction industry (Client, consultant, and contractors) are forced to limit number of staff, hiring less experience skilled personals instead of proper high experienced skilled persons to overcome the deficits on construction projects. Shortage of skilled persons, financial difficulties of owners, and incompetent subcontractors are due to uncertain situation of financial instability in region. However technical issues caused by improper feasibility study and contract prepared based on insufficient details and drawings leads incomplete design at time of tender, mistakes in design and delay in preparation and approval of drawings and revisions.

5.4 Finishing Phase

Finishing phase consists of 7 factors contributing to cause delay in projects, frequency of factors is shown in Fig.8. In Fig. 9, the analysis of Average Index value shows that the 'mistakes during construction' is highest ranked cause in this category with AI score of 3.96, 'contract claims extension of time and cost' is second major cause with AI of 3.78, 'Inadequate monitoring and control' is third major cause in finishing phase with AI of 3.72, and inaccurate time and cost estimates is fourth major cause with AI of 3.7.

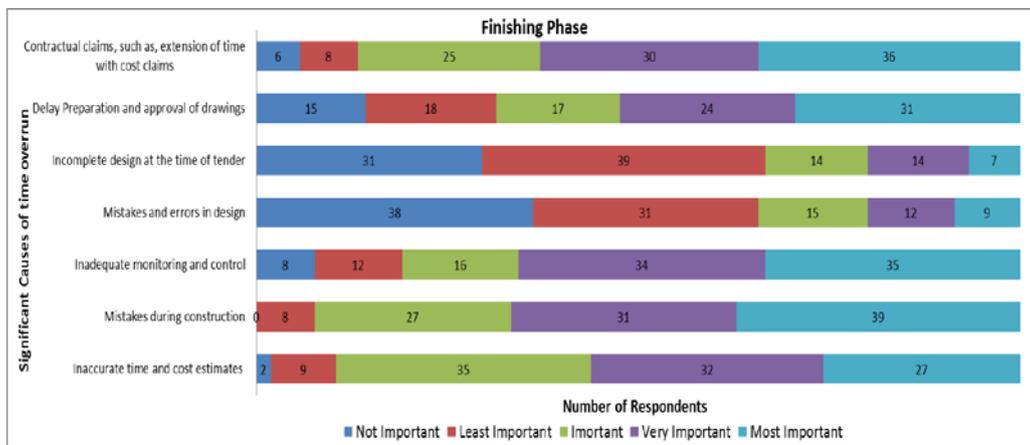


Fig. 8 - Distribution of response in finishing phase

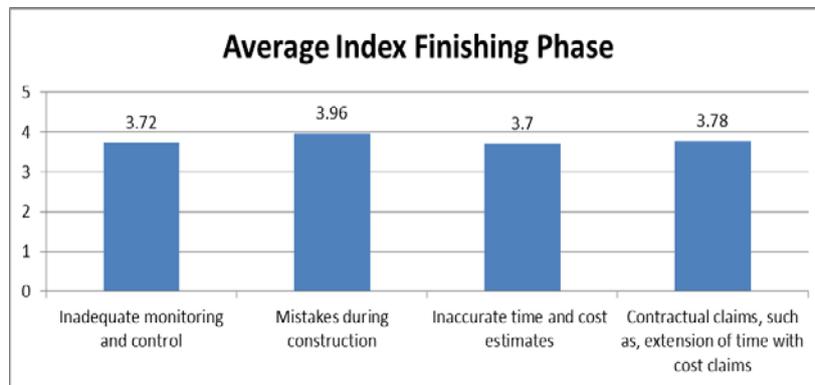


Fig. 9 - Ranking of factors causing time overrun in finishing phase

Table 4 - Client, consultant and contractor’s prospective in finishing phase

Category	Respondents	Most Significant Factors
Finishing	Client	Mistakes during construction
		Inadequate monitoring and control
	Consultant	Mistakes during construction
	Contractor	Inaccurate time and cost estimates
		Contractual claims, extension of time and cost

Table 4 shows the ranking in this phase with prospective of client, consultant and contractor. In finishing phase based on client 'Mistakes during construction' requires more finishing work and it happens due to 'inadequate monitoring and control' and improper supervision. Never the less consultant agreed with response of client on 'Mistakes during construction' and according to contractor 'Inaccurate time and cost estimates' due to lack of sufficient number of labour and improper scheduling 'Contractual claims, extension of time and cost' are considered as main causes of delay in construction projects. Construction industry extensively agreed that mistakes, errors, and faults during construction process are rehabilitated before starting finishing job that needs approvals and causes delay in finishing work and open doors for contractual claims and increase in cost. These problems happens due to in-adequate monitoring and control.

5.5 Miscellaneous Factors

In this category there are 6 factors that contributes to cause delay in the construction project, the frequency chart is shown in Fig. 10. The average index chart in Fig. 11 shows that the ‘Insufficient data collection and survey before design’ has highest AI score 4, due to this reason delay can happened because the collection of incomplete and inappropriate information will let the engineers to repeat collecting the information and its will take more time and causing delay for the project. Second cause of delay in this category is ‘Inadequate details provided in drawing with AI of 3.74, third ‘delay in obtaining permit from municipality’ with AI of 3.71, and last is ‘difficulty in accessing the site’ with AI of 3.7.

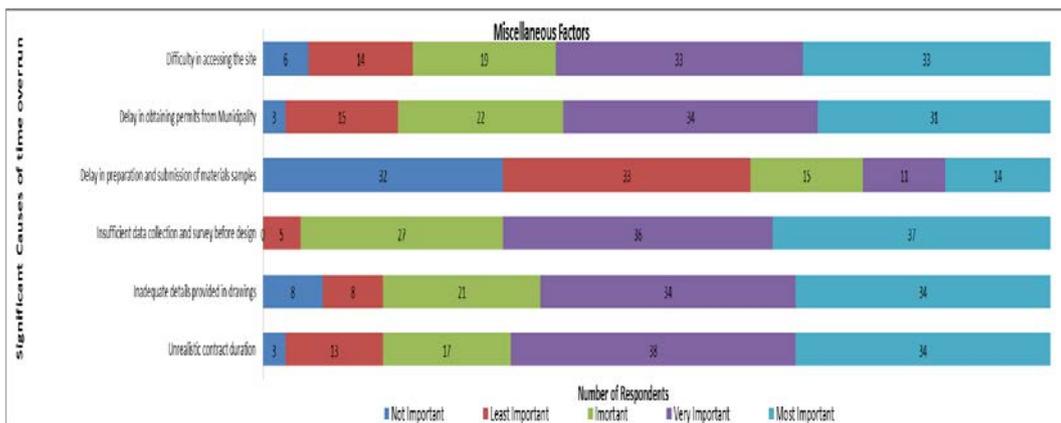


Fig. 10 - Distribution of response in miscellaneous phase

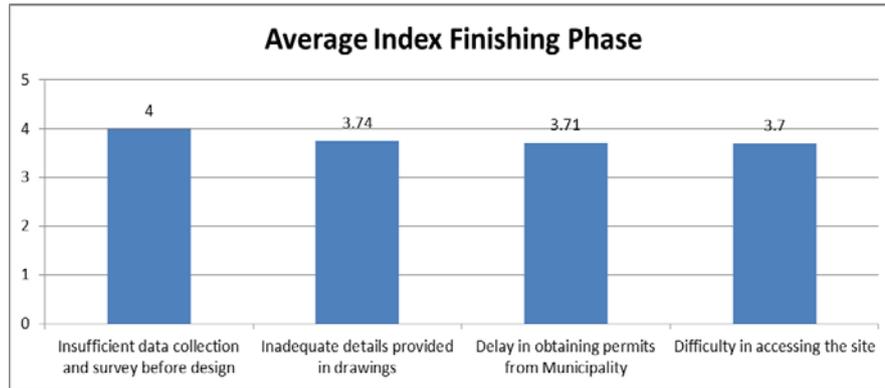


Fig. 11 - Ranking of factors causing time overrun in miscellaneous phase

Table 5 - Client, consultant and contractor’s prospective in miscellaneous phase

Category	Respondents	Most significant factors
Miscellaneous	Client	Insufficient data collection and survey before design Delay in obtaining permits from Municipality
	Consultant	Difficulty in accessing area
	Contractor	Inadequate details provided in drawing

Table 5 shows the causes delay in miscellaneous category based on client 'delay in obtaining permit from municipality' and 'insufficient data collection and survey before design' are considered as main causes of delay in projects. However consultant responses are 'difficulties in accessing site area' is main factor causing delay in construction projects, and according to contractor 'Inadequate details provided in drawings' is considered as main causes of delay in construction projects. It is widely acceptable that in-sufficient data collection and survey before designing does creates many problems during construction that requires many changes and redesigning. For any kind of re-designing or changes requires approval from government municipalities that causes more delay in construction of any projects.

6. Recommendations

6.1 Planning Phase

Planning phase is most important phase of any project, however it is widely noticed that construction industry contributors (client, consultant, and contractors) offer less attention during planning stage because it requires resources earlier than commencement of project. Later when construction commenced, all contributors face problems, and those problems needed to tackle on day by day basis. As planning stage is more related to client side, so all responsibilities during planning phase lies on client of project. Client of project should provide or stipulate consultant to provide complete schedule of planning phase of project, in order to complete planning phase on time. "Change in scope of projects" is directly related to client of project, that also causes 'frequent changes in design as well, therefore it is necessary to finalize regarding scope of project within planning timeframe together with consultant to avoid delay due to these reasons. It also can be vital and well-intentioned to include contractors of project from planning stage. This will help to avoid slow information flow between client, consultant and contractor, and also will help to produce proper schedule for project with mutual acceptance of client, consultant, and contractor. At the end of this stage all parties of construction industry should agree on project and move forward for next step, and avoid any further interference in next stage of project.

6.2 Design Phase

Designing stage is mostly related to consultant. Consultant should contribute dominant role over client and contractor to avoid any kind of problems during this stage. The most effective problem in this stage of project is 'Incomplete design at tender' that also cause 'poor design and delay in designing' that requires drastic revisions in design, schedule, and cost at later stage of project. Therefore, it is crucial to complete design prior to tendering of any project, (that is not a normal practice in construction industry). Consultant should do site visits to collect data for designing together with contractors to have their opinion. Consultant should have time-frame of designing before making tenders to avoid all kind of problems related to this issue at later stage. 'Lack of communication' is concerning problem at every stage of project. However, at designing stage consultant should arrange meetings on weekly basis together with client and contractor including design engineers of project to avoid communication problems.

6.3 Construction Phase

Construction phase is most crucial stage of any project, seeing that construction responsibilities of project belongs to contractor, thus it is necessary for contractor to perform dominant role during this stage. It is widely accepted that majority of problems during this stage are because of neglections and mis-management at previous two stages (planning and design) of project. Problems such as 'incomplete design at time of tender', 'mistakes and errors in design', and 'delay in preparation and approval of drawings' can be avoided by working properly at previous two stages (planning and design) of project. Otherwise it will become necessary for client and consultant to provide highly technical staff with manpower at site office in co-ordination with contractor with exemption of liabilities, to tackle these problems on daily basis by revising drawings, and all other related documents of contract with mutual approval.

'Financial difficulties of clients' causes 'shortage of technical personels', and 'In-competent sub-contractors'. It is easily understandable that without proper cashflow any project can face halt at any stage. Now-a-days fluctuation of oil prices and instability of economy of any country can cause worst damage to project. Therefore, it is vital for client to make sure about full budget for expected completion timeframe of project with surplus before starting any project.

6.4 Finishing Phase

In-adequate monitoring and control' causes 'mistakes and errors during construction' and subsequently it leads to the another problem of 'contractual claims extension of time and cost overrun' that requires approval from client and surplus budget. It is almost im-possible to get 100% construction without any flaws due to human error. Therefore it is advised that in contracts, budget of project and in scheduling, there should be provision of inspection and remedial work after construction stage. Contractor or/and consultant engineers with specialized in inspection and remedial work should be hired to overcome flaws during construction. Finishing work should embark shortly soon subsequent to remedial works.

6.5 Miscellaneous Factors Remedies

'In-sufficient data collection and survey before design' causes 'in-adequate details provided in drawings'. It has been mentioned in planning, design, and construction phases, that neglecting and ignoring importance of planning stage of project causes numerous problems at later stage of project. This problem can be solved by putting proper effort with resources at planning and design stage of project.

7. Summary

This research has helps to identify factor causes of delay in construction at Muscat, Khabourah, Bidbid, Musanah and Sohar cities in Oman. The most significant factors causing delay in construction process (Planning, Design, Construction, Finishing, and Miscellaneous) have been analyzed by using average index method with client, consultant, and contractor prospective. It was found during construction there are many factors causing delay of projects as compared to all other categories. However, during planning stage and designing stages is considered as more critical stages for any project. If client, consultant, and contractor works well with better understanding with each other during planning and designing stages that can come out with better results to reduce/avoid delay at later stage of construction. Furthermore for each stage of project most significant factors causing delay with respect to construction management are highlighted with client, consultant, and contractors individual and as team prospective. These findings will give a better understanding to the construction industry companies regarding flaws in management and create awareness among them for undertaking future construction projects to avoid/reduce delay. It is concluded that the government organizations or individual companies consultant and contractors can develop or improve legislation for construction projects based on this study to avoid delay in forthcoming construction projects.

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