

ANALYSIS OF FACTORS AFFECTING SUCCESSFUL COMPLETION OF INFRASTRUCTURE PROJECTS

Maziya Meeran Muhammed¹, Assistant Prof. Hasanath K²

¹M.TECH student, Civil engineering Dept, MGM college of Engineering, Kerala, India

²Assistant professor, Civil engineering Dept, MGM college of Engineering, Kerala, India

Abstract - It is undeniable that the infrastructure construction industry every day is looking for a greater effectiveness and efficiency in its techniques and methods. In infrastructure projects huge amount of money, workforce, various stakeholders are involved. Delay in any part of the project can lead to cost and time over run of the projects which can create a large loss and burden to the various parties involved in the projects. Therefore it is very important to analyze even the minute factors which influence an infrastructure project.

The purpose of this study is to examine the major technical and management issues that affects road infrastructure projects in Qatar and United Arab Emirates (UAE) and identify the factors that cause unsuccessful project completions. The paper further seeks to identify the changes that can be made to improve project success. Analytical and statistical tools have been used to determine and analyze the factors.

Key Words: Project management, Road Infrastructure, Qualitative and quantitative analysis.

1. INTRODUCTION

The infrastructural Construction industry includes the procedures involved in delivering infrastructure and the related activities. Like any other construction, it begins with plan, finance and design. And it continues until it is build and ready to use. Infrastructure construction is time and money consuming. They usually have a fixed maximum use and population and they also have specific lifespan. The construction industry contributes more than 10% of the global GDP. It contributes to more than 5% of India's GDP and construction along with real estate contributes to 19% of the GDP of UAE around 15% of Qatar. The industry employs around 7% of the world workforce. And about 16% of the Indian population depend on this industry for livelihood. With the developments in technology and business, the construction industry is continually changing. Hence, it is important for the construction companies to have new strategies and developed new applications in order to succeed. A methodology with sound engineering judgment helps in successful execution of the project and also helps to keep it within the estimated cost and time. A project can be said successful if they are completed within the given budget, time and has an acceptable quality. However, the

project performance is subjected to many variables and factors. The construction performance can be affected by the contractual relations, environmental conditions, resource and the performance of the parties.

1.1 Major Success Factors in the Infrastructure Projects

The literature review identified six key aspects important in successful project completion of infrastructure projects. Further classification of factors under the six categories will listed under coming topics.

- Pre-Project Technical studies
- Contractual Arrangements
- Humanitarian Factors
- Interactive Processes.
- Monitoring and Control
- Financial Factors

a) Pre-Project Technical studies

Planning During the pre-design stage, sufficient specifications are acquired. Some of the tasks in this stage are The Client Requirements are prepared, Develop Business Case for feasible options including review of Project Risks and Project Budget, Ratify option that best delivers Client Requirements, Review Feedback from previous projects and also undertaking site assessment and analysis. Undertake Site Appraisals. Sufficient designs and technical drawing are prepared and produced.

Following factors were found out under this category through literature studies:

- Prepare comprehensive specifications.
- Prepare adequate design and drawings.
- Prepare clear quantity take-off.
- Land Acquisition.

b) Contractual Arrangements

Identifying contractual terms and also knowing the different types of contracts. There are mainly 5 types of construction contracts. These are lump sum contracts, guarantee maximum price contracts, time and material contracts, cost plus contracts and unit price contracts. All of these have their own specific advantages and disadvantages. Following sub

factors are considered under this category:

- Understand contractual terms
- Co-ordination among parties
- Dispute resolution clauses in contract
- Risk management system in contract
- Connect contract price with price index.
- Site clearance and Mobilization.

c) Humanitarian Factors

For the success of a project it is important to make sure the availability of good human resources which would include improved knowledge, ability, skills and employee's behavior. Availability and access to material and equipment resources are also important. Up to date technical skills for the employees is an important necessity today in the construction field. And it is also important to have good amount of experience, making timely decision and quick troubleshooting capabilities. Following are the factors considered under this category:

- Resource availability
- Total years of construction
- Perception of role and responsibility
- Ability to make timely decision
- Commitment of all parties to the project
- Competency and technical skills

d) Interactive Processes.

This involves stakeholder's integration and Good relations with stakeholders. The stakeholders should be managed by the organizations with the intent to reduce negative impacts and also to ensure that there is not much obstacles in the way of successful completion of the project. The expectations of the various stake holders identified should be managed by the construction industry. Since it is possible that the project creates unexpected situations from the stakeholders, it is important to monitor the progress of the agents, the evolution of their power, and different factors that can originate these reactions. Contractors can regulate the relations between various process agents in the sector. For the project to be successful, the project director should be skillful in the management of the different stakeholders from the start to end of the project. The regular communication with the different stakeholders makes this inform their management of diverse stakes.

- Project organization chart
- Communication among stakeholders
- Positive relationship with stake holders
- Documentation and Information systems
- Accountability of work
- Awareness of quality importance

e) Monitoring and Control

Monitoring and control processes regularly check, track,

review, report and adjust the performance of the project at different instances. This is important to know the performance of the project in terms of time and cost and also to implement approved changes. Having a proper quality control and assurance systems. If quality control is not done properly then it can severely badly affect the result in terms of time and cost efficiency. Monitoring is done by having a distinct monitoring team. Automation and technology could be used to aid the process. This will serve very efficient and is an important factor today. Monitoring and control mainly are characterized by budget update systems and cost control and having an effective safety program.

- QA & QC system implementation
- Establish monitoring team
- Cost control system & budget updates
- Delay in corrective action
- Use of technology and implementation

f) Financial Factors

These factors are to ensure the money flow in construction. This means ensuring the movement of income into and the expenses out of the entity in a given time. The cash coming in should be higher than that going out. In construction industry cash flow basically means to the analysis of when money or the price will be incurred and how much amount of it will go to during the life of the project.

- Cash flow during construction
- Financial Closure
- Involvement of Financial Institutions
- Construction Corruptions
- Ability to make financial decisions at right time

1.2 Significance Infrastructure Construction Industry

This study focuses on the road and high infrastructure in the middle east region taken in consideration few completed and ongoing projects in Qatar and UAE. Large scale infrastructure projects with increasing complexity are being constructed in many countries around the gulf region. In this respect, project management is also becoming increasing complex not only because the projects are becoming larger (referred to as mega projects when investments amount to \$1 billion or more), but also because of the large number of stakeholders involved. Since mega projects can take many years to complete, responding to the changing interests and demands of stakeholders over the life of a project can make project management a challenging task (Friedman and Miles, 2002). Many surveys demonstrate that economic benefits and societal gains obtained from infrastructure developments are undervalued and the infrastructure community needs to work together on highlighting the importance of infrastructure in achieving national prosperity depends.

Strong transport connections enable urban regeneration, new job creation, and the delivery of goods and services. Ignoring the importance of infrastructure will burden economies with congested roads, unreliable and overcrowded rail services, power outages, droughts, flooding and cyber attacks. When respondents were asked about the obstacles to delivering projects, financial obstacles were the most common followed by public opposition and shortcomings in decision making.

1.3 Objectives

The aim of this research is to rank few selected infrastructure projects based on stakeholder's preferences and find out important factors affecting success of infrastructure projects that are currently used in the road and highways construction industry as well as analysis of these factors using questionnaires and software like excel and SPSS. Roads and Highways have been considered for the detailed study, because it got highest ranking in the survey conducted among different stakeholders.

Objectives of this research are to:

- Identify and Rank key infrastructure projects.
- Find out important factors affecting success of infrastructure projects
- Analysis of identified factors using questionnaire survey, excel and SPSS software.

2. LITERATURE REVIEW

Literature review is usually done to understand the topic, identification of the problem and the suitable suggestions given by various researches in their paper. During the literature review process, several resources, such as journal articles, articles in news reports, theses, websites etc. have been examined. Various researches carried out on the success and delay factors of infrastructure projects have been studied to know the problems faced in the industry across the world. It helps to find out the different possible solution that we can obtain from literature study and understand its meaning from the below listed papers.

In the thesis by **Kumar, M. B., Sumanth, P., Kumar, V., Shiva, S., & Raj, P. (2019)**. It is mentioned one of the future scopes of their thesis is to find out reasons behind the contractor's selection of the project and why they choose respective project in ranking of projects. Another scope mentioned is in-depth analysis of each factor affecting highway projects. In this work I have worked on these two scopes and conclusions and results have been made. Also, their study was on Indian roads and highways. This project focused on roads and highways in developed countries like Qatar and UAE.

RIBA (2020), The RIBA Plan of Work was initiated in 1963 to provide a framework for architects and engineers to use

on projects with their clients, bringing greater clarity to the different stages of a project. From their 2020 edition a clear picture on factors under pre-technical studies was obtained. During the pre-design stage, sufficient specifications are acquired. Some of the tasks in this stage are The Client Requirements are prepared, Develop Business Case for feasible options including review of Project Risks and Project Budget, Ratify option that best delivers Client Requirements, Review Feedback from previous projects and also undertaking site assessment and analysis. Undertake Site Appraisals. Sufficient designs and technical drawing are prepared and produced.

Gerady (2021), An article on Quantity take-off also give a clear picture on pre-technical studies factors. Making of clear quantity takeoff: It is an important part of the cost estimating process. They are used by all types of construction projects to find the actual cost, make sure that the project will be profitable for the contractor and is also an important part of the final detailed estimate. A quantity takeoff basically provides the list and quantity of all the material that will required to complete the project.

Finity (2020), Contractual arrangements is another key factor considered for the analysis. Identifying contractual terms and also knowing the different types of contracts. There are mainly 5 types of construction contracts. These are lump sum contracts, guarantee maximum price contracts, time and material contracts, cost plus contracts and unit price contracts. All of these have their own specific advantages and disadvantages. Moreover, Connecting the contract price with the price index is also very important. It also includes Good Co-ordination between all the different roles involved and the contract should include correct dispute resolution and they should also include formal risk management system.

Nassichuk (2015) had undergone a study on mobilization and site clearance which also come under the same factor, Mobilization is one of the first stage of the project where various preparations takes place on the site before any work starts. By this time, the contractor has been selected and building plans have typically been approved by municipality.

Pampliega (2013) conducted a study on stakeholders roles, Stakeholders integration and Good relations with stakeholders. The stakeholders should be managed by the organizations with the intent to reduce negative impacts and also to ensure that there is not much obstacles in the way of successful completion of the project. The expectations of the various stake holders identified should be managed by the construction industry. Since it is possible that the project creates unexpected situations from the stakeholders, it is important to monitor the progress of the agents, the evolution of their power, and different factors that can originate these reactions. Contractors can regulate the relations between various process agents in the sector. For the project to be successful, the project director should be skillful in the management of the different stakeholders from the start to end of the project. The regular communication

with the different stakeholders makes this inform their management of diverse stakes.

Hungas & Murdoch(2001) made a study and which was taken in consideration to find factors under Humanitarian factors. Knowing the Responsibility and Role and commitment of everyone in the project is important. This includes roles of client, architect, structural and civil engineer, contractors, sub contactors, quantity surveyor, clerk of works, local authorities, factory and building inspector, suppliers, nominated suppliers and the builders. The institutions and other standard provide have to define different terminologies. For instance, the BSI (British Standards Institution 1985) has provided some very straight forward definitions for various roles involved in construction. Even though these will help to clarify define the roles, they don't actually provide much information for legal agreements. On the other hand, some literatures and institutions have defined the responsibilities also.

Cash flow in construction (2021) journal explains different financial factors which affects a construction projects. That means to ensure the Money flow in construction, through ensuring the movement of income into and the expenses out of the entity in a given time. The cash coming in should be higher than that going out. In construction industry cash flow basically means to the analysis of when money or the price will be incurred and how much amount of it will go to during the life of the project. It is necessary to predict the money flow to make sure that a good amount of funding is in place and sufficient drawdown facilities are present.

Financial close vs financial closure (2021) mentioned that it is important to make sure there is Financial Institutions involvement and a financial closure is considered for the projects. It means the process of completing all project, its financial transactions, finalizing and closing the project financial accounts and disposing of project. And it is important to have the Ability to make right financial decisions and avoiding construction corruptions.

3. METHODOLOGY

The research in this thesis is based on literature reviews, construction professionals opinions, analytical tools and detailed study on the project histories of different companies from their websites. Study on the company's previously completed projects is a very good method of understanding a complex subject and also create a deep understanding of the data. It really helped to rank the projects based on contractor preference. Given, the nature of the research questions, a qualitative approach was selected for this investigation. Researchers using qualitative methods gather an in-depth understanding of natural and human behavior and the reasons that govern such phenomena. Techniques commonly used include interviews (structured or unstructured), focus group discussions, literature and material reviews and observation techniques. Research methodology adopted for this project is given as follows:

1. Identify the scope of study
2. Defining the scope
3. Research proposal
4. Literature review
5. Questionnaire preparation
6. Pilot study
7. Ranking of Projects
8. Data collection
9. Data analysis
10. Result and discussion.
11. Summary, conclusion and future scope

3.1 Project Ranking

For easy analysis major infrastructure projects were considered and ranked based the contractor's preference in order to find most common work chosen by the companies. Also, the reasons for their choices were noted. It was found road and highway works are the most preferred and common work among the contractors. Below projects were considered for ranking.

- Roads and highways
- Water supply: Drainage and sewage
- Bridges, interchanges and tunnels
- Industrial buildings
- Power generation civil works
- Telecom
- Oil and gas

3.2 Questionnaire Design

The questionnaire was designed based on the factors identified for the analysis of factors affecting successful completion of infrastructure projects. A questionnaire survey was developed to assess the perception of contractors, clients and consultants of the relative important causes. The questionnaire is mainly based on Likert's scale of 5 ordinal measures from 0 to 4 according to the level of importance and performance. Each scale represents the following rating:

- 0 - No effect at all
- 1- Fairly Important
- 2- Important
- 3- Very Important
- 4- Critically Important

In surveys using Likert's scale a common form is an assertion, with which the person may agree or disagree to the varying degrees. In scoring, numbers are usually assigned to each option (such as 0 to 4). A benefit is that questions used are usually easy to understand and so lead to consistent answers. A disadvantage is that only a few options are offered, with which respondents may not fully agree. As with any other measurement, the options should be carefully selected from set of questions or statements that act together to give a useful and coherent picture. A problem can occur where people may become influenced by the way they have answered previous questions.

3.3 Data Collection

Data collection is the most critical part of the study since the accuracy of the data will determine the success or failure of the research. Data obtained through these questionnaires will be analyzed accordingly using appropriate analysis techniques. Responses from questionnaires will then be compiled and analyzed. Data collected from different questions will be gathered to answer different objectives. Analysis is done using the statistical methods. The questionnaire survey was conducted from about thirty companies. Most of the data was collected from infrastructure construction companies and interview was done with project managers, contractors, clients, site in charge.

3.5 Relative Importance Index

Relative importance index was used to determine the relative significance and ranking of the problems faced by small scale construction contractors.

$$RII = \Sigma W / (A * N)$$

Where,

W- Weighting given to each factor by the respondents (ranging from 0 to 4)

A- The highest weight (i.e. 4 in this case)

N- The total number of respondents (25)

The RII ranges from 0 to 1, higher the value of RII more important the factor is. These rankings make it possible to compare the relative importance of the factors.

4. RESULT AND DISCUSSION

4.1 Data Analysis

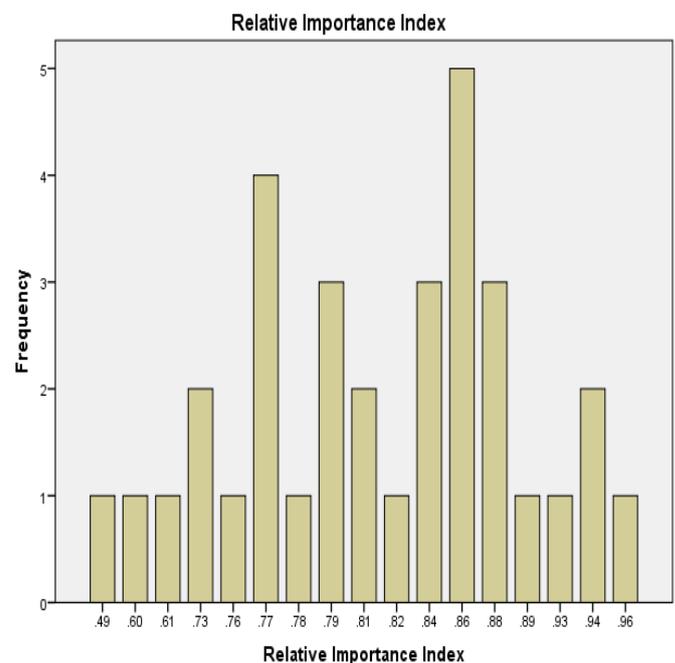
The data collected from survey was subjected to the descriptive Statistical analysis to rank the problems and correlation analysis was used in order to test the relationship between the factors for a sustainable development. The analysis is done by using Excel and SPSS software.

Table -1: Relative Importance Index of all Factors

SI.No	Factor	RII
A1	Prepare comprehensive specifications	0.79
A2	Prepare adequate design and drawings	0.81
A3	Prepare clear quantity take-off	0.61
A4	Land Acquisition	0.6
B1	Understand contractual terms	0.94
B2	Co-ordination among parties	0.88
B3	Dispute resolution clauses in contract	0.76
B4	Risk management system in contract	0.77
B5	Connect contract price with price index	0.73
B6	Site clearance and Mobilization	0.73
C1	Project organization chart	0.49
C2	Communication among stakeholders	0.77

C3	Positive relationship with stake holders	0.81
C4	Documentation and Information systems	0.84
C5	Accountability of work	0.86
C6	Awareness of quality importance	0.88
D1	QA & QC system implementation	0.86
D2	Establish monitoring team	0.79
D3	Cost control system & budget updates	0.84
D4	Delay in corrective action	0.86
D5	Implementation of safety programs	0.77
D6	Use of technology and implementation	0.88
E1	Resource availability	0.96
E2	Total years of construction	0.84
E3	Perception of role and responsibility	0.78
E4	Ability to make timely decision	0.93
E5	Commitment of all parties to the project	0.79
E6	Competency and technical skills	0.86
F1	Cash flow during construction	0.89
F2	Financial Closure	0.86
F3	Involvement of Financial Institutions	0.77
F4	Construction Corruptions	0.82

Graph-1: Relative Importance Index Vs Frequency of all Factors



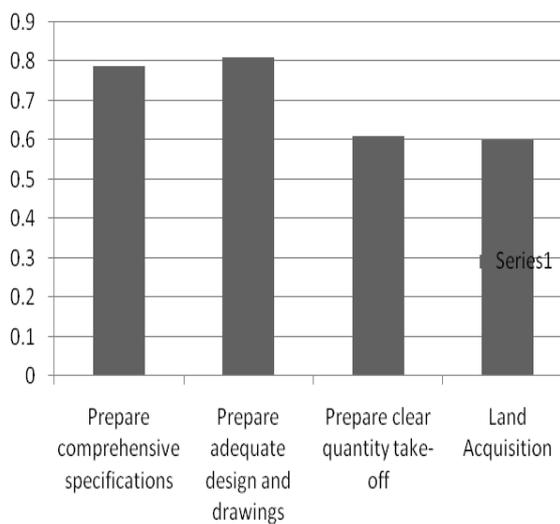
4.2 Data Collection and Statistical Analysis

Respondents with various profiles were involved in the survey. Important aspects considered for the selection of

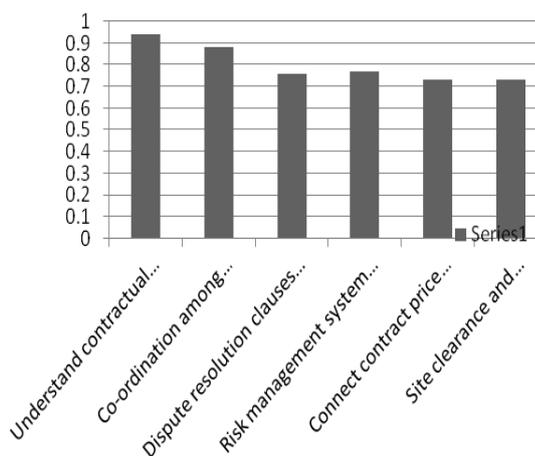
companies and respondents were years of experience and the company history of successful projects. Only companies ranked top in infrastructure were considered and only respondents above 5 year experience in the field. Survey was done among 25 construction professionals and data was analysed using excel and SPSS. Below graphs were formed for each category of factors based collected data.

Also a statistical analysis of the factors based on the respondent ranking was analysed using SPSS. Mean, median, variance and standard deviation were produced along with maximum and minimum among each category.

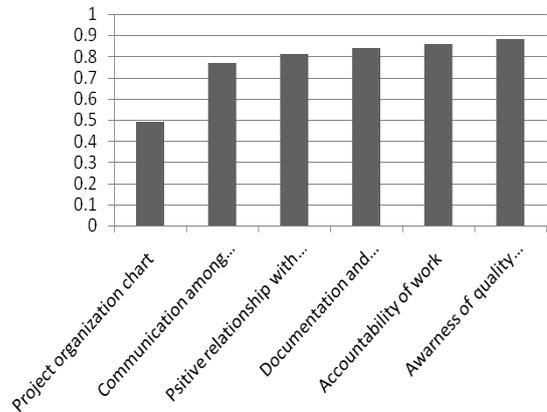
Graph 2: Pre Project Technical Studies



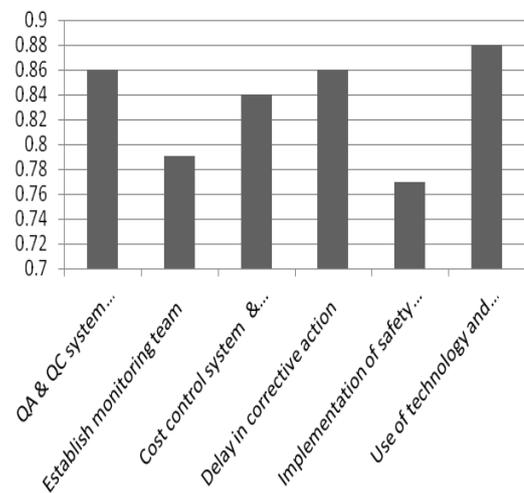
Graph 3: Contractual arrangements



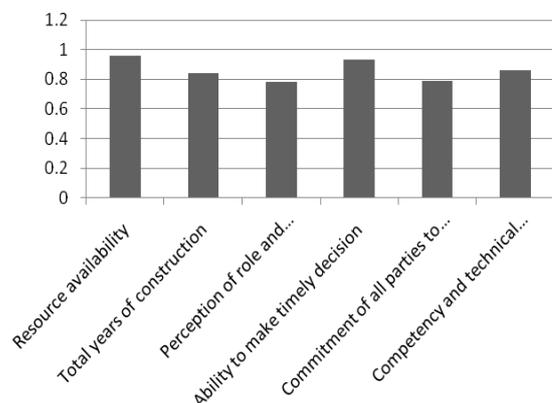
Graph 4: Interactive processes



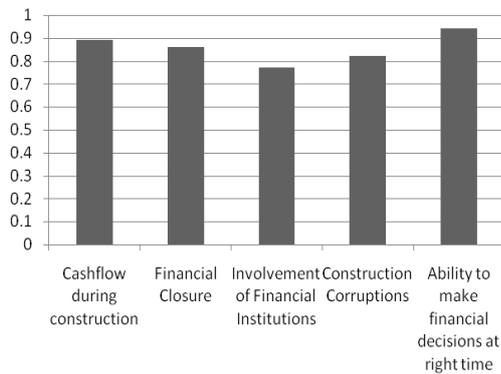
Graph 5: Monitoring and control



Graph 5: Humanitarian factors



Graph 6: Financial related-factors



5. CONCLUSIONS

- In accordance with the presented data analysis, it seems to recognize the factors which are most influenced and that are least influenced in the success of road and highway projects.
- The factors which are most important for the success of a project can be briefed in six points give below.
- Adequate design and preparation of proper drawings is a key factor for a project success.
- Every party involved in a project should have proper understanding on the contract terms and conditions in order to avoid great financial losses.
- In modern construction use of technologies plays a key role in the successful completion of a project.
- Success always lies in manpower. Therefore proper management teams to take timely decisions are very important in the success of a project.
- Another important factor is timely financial decisions. Financial decisions are very important to keep a project under budget. It involves cost control, proper teams to monitor costs etc.
- Proper material management also plays an important role in project success.
- Few points which considered as above factors are also found out through the analysis. Those points need to be studied in further for finding out the influence of those factors on the project success. Those factors are listed below.
 - Involvement of financial institutions.
 - Perception of roles and responsibilities.
 - Implementation of safety programs
 - Organization chart
 - Proper quantity take-offs.
- Organization charts and quantity take offs are properly followed all reputed firms. But it doesn't have same influence as other factors on project success need to be studied and can be considered as a future scope of this project.

6. SUGGESTIONS

- Proper assignment and withdrawal of project teams should be done to avoid manpower shortage and budget overruns. It also helps to reduce time delays.
- Stakeholder relationships need to be improved for better end results. Proper communication and coordination among client, contractor and suppliers is very important.
- Proper evaluation of completed projects during their defect liability period is very important in order save money after completion of a project.
- Proper contract closures need to be made during pre-project stage.
- Proper maintenance of project management team is very crucial in the success of a project. It involves a project management team, consultants and contractors. Also should make sure proper coordination among these parties.
- During tendering process technical competency of the contractors need to be give preference. Most of the time the best contractor to select is not the one who offered the lowest price since there are hidden costs such as rework cost with them.
- Proper schedule and budget planning is very important prior to start of the project.
- All the final payments should be given on time to reduce risks of time overruns in project completion and handing over of the project.

REFERENCES

- ASCE. (2003). "Manuals and reports on engineering practice–No. 45." Consulting engineering- A guide for the engagement of engineering services, New York.
- Chang, A. S.-T. _2002_. "Reasons for cost and schedule increases for engineering design projects." J. Manage. Eng., 18_1_, 29–36.
- Abd Majid, M. Z., and McCaffer, R. (1998). "Factors of non-excusable delays that influence contractors' performance." J. Manage. Eng., 14(3), 42–49.
- V. Sanvido et al., "Critical success factors for construction projects", Journal of Construction Engineering and Management, vol. 118, no. 1, pp. 94–111, 1992.
- J. Rockart, "The changing role of the information systems executive: a critical success factors perspective", Sloan Management Review, vol. 24, no. 1, pp.3- 13, 1982.
- Fildes, B. N., & Elsayed, Y. H. (2012). Transportation infrastructure development in the UAE: Stakeholder perspectives on management practice. Researchgate.
- Cash flow in construction. (2021, April 15). Retrieved from Design Buildings Wiki: [https://www.designingbuildings.co.uk/wiki/Cash_flow_in_construction#:~:text=In%20very%20general%20terms%2C%20cash,or%20other%20entity\)%20over%20time.&text=In%20construction%2C%20however%2C%2](https://www.designingbuildings.co.uk/wiki/Cash_flow_in_construction#:~:text=In%20very%20general%20terms%2C%20cash,or%20other%20entity)%20over%20time.&text=In%20construction%2C%20however%2C%2)

- 0the%20term,the%20life%20of%20a%20project.
- [8] Financial close vs financial closure. (2021). Retrieved from <https://textranch.com/134360/financialclose/or/financial-closure/> Textranch:
- [9] Finity, J. (2020, February 20). Construction Contracts: Understanding The 5 Main Contract Types. Retrieved from <https://www.levelset.com/blog/construction-contracts-5-main-types/> Level set:
- [10] Gerady, J. (2021, February 19). What Is A Quantity Takeoff In Construction? Retrieved from Proest: <https://proest.com/construction/takeoffs/quantity-takeoff/>
- [11] Hungas, W., & Murdoch, J. (2001). Roles in construction: Analysis and Terminology. Construction Industry Publications.
- [12] Kumar, M. B., Sumanth , P., Kumar, V., Shiva, S., & Raj, P. (2019). Analysis Of Factors Affecting Successful Completion Of Infrastructure Projects.
- [13] Nassichuk, E. (2015, June 5). Demolition, Site Clearing & Mobilization. Retrieved from UBC: <https://blogs.ubc.ca/residentialconstructionwatershedhealth/construction-phases/demolition-and-site-clearing>
- [14] Oad , P. K. (2016). Innovation In The Road Construction Sector And Its Benefits To The Industry.
- [15] Pampliega, C. J. (2013, October 22). Stakeholder Management in the Construction Sector. Retrieved from Salinero [pampliega: https://salineropampliega.com/2013/10/stakeholder-management-in-construction.html](https://salineropampliega.com/2013/10/stakeholder-management-in-construction.html)
- [16] RIBA. (2020). RIBA Plan of work. y RIBA, 66 Portland Place, London, W1B 1AD.
- [17] Sohal, Fildes., & Hawas. (2015). Transportation infrastructure development in the UAE: Stakeholder perspectives on management practice2015Research Gate 492-514