T.C.
ISTANBUL GEDİK UNIVERSITY
INSTITUTE OF GRADUATE STUDIES

THE IMPACT FACTORS OF CONSTRUCTION PROJECT DURATION AND MANAGEMENT PROCESS

MASTER'S THESIS

Omer Sabbar ALHURAISHI

Engineering Management Department

Engineering Management Master in English Program

JULY 2022

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Thesis Advisor: Assist. Prof. Dr. Gokhan KAZAR

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1) Tez Danışmanı: Dr. Öğr. Üyesi Gökhan KAZAR

2) Jüri Üyesi: Dr. Öğr. Üyesi Redvan GHASEMLOUNIA

3) Jüri Üyesi: Dr. Öğr. Üyesi Mehmet UĞURAL

DECLARATION

I, Omer Sabbar Alhuraishi, do hereby declare that this thesis titled as “The Impact Factors of Construction Project Duration and Management Process” is original work done by me for the award of the master’s degree in the faculty of Engineering Management. I also declare that this thesis or any part of it has not been submitted and presented for any other degree or research paper in any other university or institution. (04/07/2022)

Omer Sabbar ALHURAISHI

PREFACE

This thesis project would not have been finished and completed without enormous contributions of many people. First, my deep gratitude and appreciation are expressed to Associate Professor Dr. Gokhan KAZAR, who supervised me, for the invaluable support and endless patience throughout the work; his advices and guidance given by him has been a great support to accomplish the research. I wish to acknowledge Professor Dr. Hassan Naji Salman for his precious and constructive comments. My sincere thanks are also extended to Dr. Ali Al- Khateeb for his time and tolerance during the online meetings. Lastly, utmost and heartful thanks and gratitude are extended to the kind and generous people who beared all difficulties to support me with my path, my dear beloved parents for their unlimited support, patience and continuous encouragement study.

July 2022 Omer Sabbar ALHURAISHI

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THE IMPACT FACTORS OF CONSTRUCTION PROJECT DURATION AND MANAGEMENT PROCESS OF WATER PROJECTS IN BAGHDAD CITY- IRAQ

ABSTRACT

The execution course of water construction projects faces many challenges, one of these challenges is the inability to complete projects on the planned time schedule. There are many project planning success criteria, the most commonly used criteria for successful projects are fulfillment of the planned schedule, quality and financial requirements. The present research aims at investigating the impact factors of construction project duration and management process of water projects in Baghdad.

An on- line questionnaire- based investigation of the water projects in Baghdad is conducted by collecting the required data. The targeted population of the investigation consisted of groups of 122 experts and specialists of engineers working in the design, planning, execution, management and rehabilitation fields of water and sanitation projects in various directorates following both Iraqi government and other establishments (e.g. Ministry of municipalities and public works, Mayoralty of Baghdad, water directorate) and UN agencies (i.e., UNICEF and UNHCR) both in management and lower levels.

There are many techniques to identify the impact of project duration on management control and quality. An ANOVA technology is one of them. An Analysis of Variance model (ANOVA) is implemented for analyzing data that are collected from the respondents. Contradicting variance as well as the factors having anegligible variance are being helpfully found out. ANOVA single factor test is implemented to determine how significant or effective is a survey or experimental results. Reliability of a qualitative study is the research dependability so that Cronbach's Alpha coefficient (α) has been used for checking questionary's reliability.

Analysis of the results reveals that, for all factors investigated, the level of significance of some factors is more than moderate; that of other factors is almost high belonged to the Other factors related-weak site management &inaccurate field investigation, Consultant Factors-limited collected data and survey prior to design, Material poor quality of construction materials., Consultant Factors-poor communication and coordination., Material related-poor planning of supply plan for materials., Consultant Factors-mistakes and discrepancies in design documents., Contractor and workers/personnel related-frequent change of sub-contractors., Consultant Factors-nonclear and insufficient detailed reference drawings, Contractor with workers/personnel related-improper construction methods implement; almost the percent ranged between 82%-80% and according to Standard Deviation (variance from 0.916 to 0.933).

Suggestions for further investigation involve improving the way of implementing and focusing on these issues in the analysis.

Keywords: *Duration, delay causes (factors), Quality control, Management control, construction projects, project management, Water project, questionnaire survey, ANOVA*

IRAK BAĞDAT SU PROJELERİNİN İNŞAAT PROJE SÜRESİ VE YÖNETİM SÜRECİNİN ETKİ FAKTÖRLERİ

ÖZET

Su inşaatı projelerinin yürütme süreci birçok zorlukla karşı karşıyadır, bu zorluklardan biri de projelerin planlanan zaman çizelgesinde tamamlanamamasıdır. Birçok proje planlama başarı kriteri vardır, başarılı projeler için en yaygın olarak kullanılan kriterler planlanan takvim, kalite ve finansal gereksinimlerin yerine getirilmesidir. Bu araştırma, Bağdat'taki su projelerinin inşaat proje süresi ve yönetim sürecinin etki faktörlerini araştırmayı amaçlamaktadır.

Gerekli veriler toplanarak Bağdat'taki su projelerinin çevrimiçi ankete dayalı bir araştırması yapılır. Araştırmanın hedef kitlesi, Türkiye'deki yetkili departmanda su projelerinin inşaatı ve rehabilitasyonu başta olmak üzere su ve sanitasyon sektöründe çalışan 122 uzman ve uzman mühendis grubundan oluşuyordu. Irak hükümeti ve kamu sektörü bakanlıkları (örneğin: Belediyeler ve bayındırlık işleri Bakanlığı, Bağdat Belediye Başkanlığı, su müdürlüğü) ve BM kurumları (yani, UNICEF ve UNHCR) hem yönetim hem de alt düzeylerde.

Proje süresinin yönetim kontrolü ve kalitesi üzerindeki etkisini belirlemek için birçok teknik vardır. ANOVA teknolojisi bunlardan biridir. Ankete katılanlardan toplanan verileri analiz etmek için bir Varyans Analizi modeli (ANOVA) kullanılır. Faktörlerde ihmal edilebilir varyans olan faktörlerin yanı sıra çelişen varyansı bulmak da yararlıdır. Bir anketin veya deneysel sonuçların önemi, bir ANOVA tek faktör testi kullanılarak bulunur. Nitel bir araştırmanın güvenirliği araştırma güvenirliğidir, bu nedenle anketlerin güvenirliğini kontrol etmek için Alpha Cronbach katsayısı (α) kullanılmıştır.

Veri analizi sonuçları, tüm faktörlerin orta düzeyden daha fazla olduğunu ve neredeyse yüksek olan en yüksek seviyenin, diğer faktörlerle ilgili - zayıf saha yönetimi ve yanlış saha araştırması., Danışman Faktörler - yetersiz veri toplama ve ankete ait olduğunu göstermiştir. tasarımdan önce. , Malzeme ile ilgili-inşaat malzemelerinin kalitesiz., Danışman Faktörler-zayıf iletişim ve koordinasyon., Malzeme ile ilgili-malzemeler için tedarik planının zayıf planlaması., Danışman Faktörler-tasarım belgelerindeki hatalar ve tutarsızlıklar., Yüklenici ve işçiler/personel ile ilgili- taşeronların sık değişmesi., Danışman Faktörler-referans ve/veya çizimler açısından belirsiz ve yetersiz detaylar., Yüklenici ve işçiler/personel ile ilgili-uygun olmayan inşaat yöntemlerinin uygulanması; neredeyse yüzde, %82-80 arasında ve Standart Sapma'ya göre (0.916'dan 0.933'e varyans) değişiyordu.

Bu konuları analize dahil ederek ve gelecekteki araştırma çalışmalarında bunlara odaklanarak iyileştirme ihtiyaçları, çalışmanın temel önerileridir.

Anahtar kelimeler: *Süre, gecikme nedenleri (faktörler), Kalite kontrol, Yönetim kontrolü, inşaat projeleri, proje yönetimi, Su projesi, anket araştırması, ANOVA*

1. INTRODUCTION

Project duration is one of the main categorization elements of projects management. Most commonly adopted criteria in determining a successful project depend on the tri-constraint model that consists of project period, finance, and scope; considering quality as the axial theme. All factors are interrelated such that when one factor varies, the other two factors vary accordingly. i.e., when scope increases at no increase with time and cost, a weak quality of work is obtained. Also, decreasing time at no decreased scope results in weak quality at constant cost. A successful project is identified by being achieved within the specified time schedule, within the specified budget at the required level of quality, and fulfills the requirements laid out by the by the clients or the stalk- holders. The factors that determine a successful achievement for construction projects may be divided into five main groups, those are;

1. Consultant- related factors: Involves time lags due to work permissions, inspections, and rigidity of the consultant.
2. Contractor and workers/ personnel factors: involve factors under the responsibility span of the contractor, like managing and planning the site, weakness in experience, mistakes while construction, troubles associated with sub-contractors and problems with construction procedures.
3. Equipment-related factors: These factors, when choosing the appropriate equipment, affect production quality, hence resulting in elevated efficiency, cost savings, profitability of the project, as well as improved safety at the construction site.
4. Material-related factors: construction materials of the project are characterized by their quality, supply ability, faults and deficiency.
5. Finally, other factors related.

The “Fishbone diagram”, Fig. (1.1), classifies these five factor groups. This diagram

represents an analytic technique for specifying systematically the effects and their causes. Moreover, the diagram presents a clarified detailed interpretation of those causes. Also, this technique helps finding solutions to interconnected issues, since all group thoughts are organized to set the issue's main drivers. Similarly, this tool can be implemented for the decision and comprehension of the interrelated associative causes and effect in each issue.

Figure 1.1: Fishbone Structure Shows Cause-Effect of Impact Project Duration

The present research investigates the impact factors of construction project duration and management process of water projects in Baghdad.

1.1 Background

Water projects in Iraq are one of the main tasks under special focus. Their priority was supported by the authorities after the war effects of devastation of the infrastructure of the country, and the disastrous changes in the environment especially in the last few decades.

Environmental Survey in Iraq 2016 (MOP; 2016) survey results showed that proportion of population served with potable water nets in 2010 was (86.8%): (urban 91.4%, rural 75.0%). In comparison with same survey in 2010 was (78.7%): (urban 86.1%, rural 61.1%). Survey results also showed that number of water production stations were (5636) (water projects, water stations, stations installed on wells, desalination stations & solar energy stations 445,230,336,4361,264 continually) Proportion of working stations (78.7%), partially working (11.1%), non-working stations (10.2%).

Updated and accurate data and knowledge about different factors of the effect of project duration on management control and quality for construction of water projects have to be importantly considered, to fulfill the required global standard classifications essential for international corporations or for comparing the changes in the country within specific times in order to facilitate better and more accurate decisions and policies makers take the appropriate strategies to develop and upgrade water projects. I hope to achieve all the objectives of this survey data to use in developing plans and strategies for promoting water projects and access the paramount objective.

1.2 Objectives

The survey aims at reviewing efficiency, effectiveness, relevance, and sustainability of the project implementation. Particularly, to record the results and determine the effect of project duration on management control and quality and relate them to the global objectives and presumed results laid out in the project documentation. The case study survey is to provide a database on:

1. By assessing the impact of below factors on project duration and management process.
    - Project duration effect on quality management
    - Project duration effect on control management
    - Effect of staff changes on project duration
    - Effect of budget on project duration
    - Effect of budget effect on quality
2. By assessing the impact of consultant factors on project duration and

management process.

- Time lag when approving major variations in the scope of project
- Weakness of communications and coordination
- Insufficiently experienced consultant
- Errors and mismatches of the design documentation
- Foggy and insufficient details of reference and/or drawings.
- Inadequate or poor survey and collected data prior to designing
- Absence of high- level software for engineering design
- Struggles between the consultant, design engineer and the contractor
- Drawings preparing and approvement

3. By assessment of the effect of contractor along with workers/personnel related factors on quality management and project control.

- Lack in unskilled & skilled workers.
- Personal troubles among labor
- Weak support to the contractor to achieve earlier than schedule
- Repetitions of works caused by mistakes while constructing
- Troubles among contractors and other parties
- Weak coordinations and communications
- Inadequate methods implemented in construction
- Continuous multiple changing of sub-contractors
- Delays in site mobilization

4. By assessing the impact of equipment's factors on project duration and management process.

- Equipment faults and failure
- Poorly- skilled operators of equipment
- Inappropriate allocation of equipment
- Inappropriate choice of equipment type and capacity
- Low efficiency of equipment

5. By assessing the impact of Material's factors on project duration and management process.

- Shortage in market in materials of construction
- Time Lag in material delivery

- Damage in sorted material
- Variations of specification and type of materials construction
- Escalation in materials prices
- Low materials quality for construction
- Weak planning for material supplies
- Supplying materials that are inappropriate for the project current needs.

6. By assessing the impact of other factors on project duration and management process.

- Accidents during construction
- Underestimation of time of completion
- Geological troubles in the construction field
- Weak management of the site and inaccurate site analysis
- Application of safety aspect
- Delays of permissions obtained from municipality
- Delays in services supplied by the water, electricity and other utilities
- Complex type, scale and other specifications of the project
- Legal conflicts among participants of the project

7. By assessing the list of proactive steps for avoiding or reducing water projects delay.

- Redundant meetings for progress discussions
- Utilizing modern technology infrastructure
- Utilizing appropriate and updated construction equipment
- Use appropriate construction methods
- Hire skilled personnel (workers and engineers)
- Effective strategic/risk planning
- Appropriate procurement of materials
- Precise estimation of initial costs
- Monitoring the construction process
- Appropriate plans and schedules of the project
- Thorough and suitable design within a required time.
- Supervision and management of the construction site
- Safety precautions

2. LITERATURE REVIEW AND RESEARCH METHODOLOGY

2.1 Introduction

Successful projects are determined by proper management and quality control that affects all stages of the project progress plan. One of the attributes and features of successful management for any project is to handover the project on the specified delivery date and at good quality.

A cope of studies was conducted to investigate the parameters affecting project achievement at different countries of different regions. Murali (Murali, 2006) investigated the factors responsible for the time overrun in completion time of construction projects in Malaysia, the factors have been categorized into ten significant factors; inappropriate planning, weak site management and insufficient experience of the contractor, insufficient financial payments by the client after completing the works, issues concerning the subcontractors, lack of materials supply, labor provision, availability and failure of equipment, communication outage among parties and finally errors accompanying construction phase. Six basic affecting factors are extravagant time and cost, arguments, adjudication, litigation, and massive abandonment. In construction projects in Zambia, it was revealed that the vast majority reasons of delays, escalated costs and quality deficiency of construction projects in Zambia are delay of payments, shortage of finance in relation to the client or the contractor side, revisions made to the contract, financial issues, issues related to materials supply, modifications of design drawings, staffing issues, absence of equipment, weak supervision, construction errors, weak coordination in the field, specification changes, workers arguments and abandonment.

2.2 Terminologies

2.2.1 Quality

Quality is defined as the degree of excellence in a competitive sense; such as reliability, serviceability, maintainability, or even individual characteristics (International Organization for Standardization) ISO 8402, (1994). The importance of quality put it as a great area of concern in construction of projects. Many criticisms in relation to low quality in construction projects that been delivered. So that more time and increasing in cost have been spent in correction of problems during the snagging process and the majority of construction projects that suffering from time overrun.

2.2.2 Quality Control

Both ANSI (American National Standards Institute) and ISO have been defined quality control as an operational technique and activity

2.2.3 Quality Management

All activities of overall management operations are referred to as quality management, especially supreme leadership of management that specifies quality policy objectives and responsibilities for all members of the organization.

2.2.4 Relationship between project scope, quality, cost and schedule

Fig. (2.1) shows the mutual relationships among scope, schedule, cost, and quality. The four constraint items are linked such that any minimal variation of one constraint will influence other constraints accordingly, as discussed below (academia.edu).

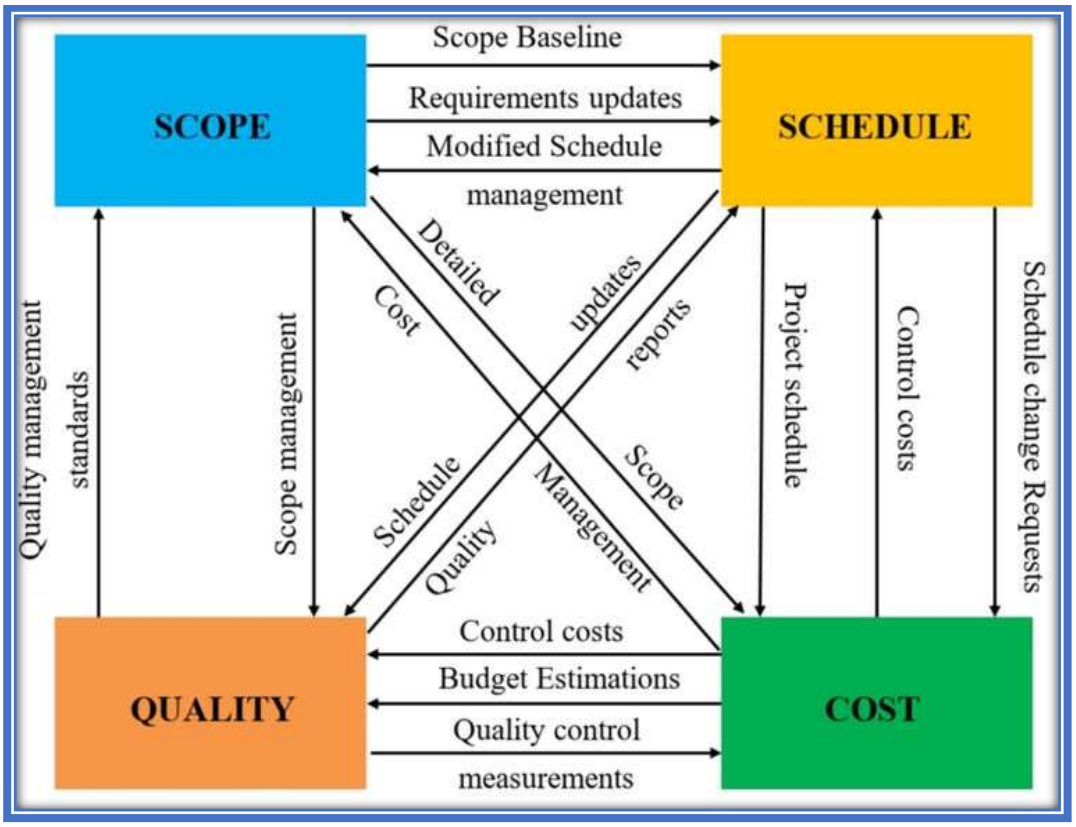


Figure 1.2: The Mutual Relationships Among Scope, Schedule, Cost, and Quality of the Project

2.2.4.1 Change of scope

When clients consider a project scope vital, new activities alongside the project can be added according to the availability of more detailed information. Increased scope by this way may cause the following:

- A compromise of quality must follow any lags in the deadlines of projects.
- Increasing the project finance for new/update resources and deliverables must accommodate the scope.

2.2.4.2 Change of schedule

When a schedule of any project is crucial, flexibility should be expected in cost and scope, since quality level may become lower subsequently. So that, any changes of the timeline, results in the following consequences:

- Any modification of the schedule requests additional allocation of resources for project, finally, will increase the cost and affect the quality.

- Decreased/ squeezed timeline requires scope to be reduced accordingly.

2.2.4.3 Change of cost

When it is necessary to commit to the allocated budget, some flexibility about the project's timelines and scope is expected from the clients or else, deliverables quality will be affected. For cases with raised costs, the following consequences may occur;

- Project deadlines will be obstructed.
- The scope will increase.
- Deliverables quality will be reduced

2.2.4.4 Change of quality

When considering quality to be vital, the quality requirements is produced and stated clearly by the clients at the early phases. If, however, the outcomes quality doesn't match the prescribed standards of quality, the following ramifications possibly appear:

- In case of clients being unsatisfied with the outputs, the product will not be approved, hence increasing both cost and schedule of the project.
- When performing a project rework, scope may be improved to have customer's needs satisfied.

2.3 Definition of Duration

Duration (sometimes also known as calendar time) means the gross time elapsed for completing an activity according to the allocated project resources. It is measured from the date of the beginning of the starting task until the date when the last task ends, excluding off days such as holidays or other non-working days. Furthermore, it is an important factor in scheduling, it is the gross time that it measured in workdays, hours, or weeks taken for completing a project and depends on the resource's availability and capacity. Successful and accurate estimation of project duration is a key factor of success for any construction project, it is largely influenced by numerous uncertain but predictable factors. When the project is not delivered within the specified period, all parties suffer. For example, clients suffer due to the

unfulfillment of their objectives, their business goals will not be met, contractors suffer losses caused by the escalated costs, overheads, and penalties. Subsequently, the project staff (Specialists, managers, engineers, etc...) are obligated to practice how to perform various activities/ tasks to have a project achieved within the estimated calendar time. The estimation of project duration is not always an easy job, it requires a project manager with some theoretical knowledge accompanied with practical and methodological experience. Finally, estimating the calendar time for a project and its various stages, helps managing a project successfully to come in on time and on budget.

2.4 Definition of Time Overrun

Time delays in completing construction projects is a major problem in the public sector. Time overrun is referred to as "a condition where a construction project does not complete within the designed schedule". The responsibility for delay in construction projects lies on different stakeholders (simplilearn.com).

2.5 Factors Affecting Time/Duration in Construction Projects

Various factors have been specified by different researchers such as Henry et. al., 2007, Ghaleb (2013), Love et al (2013) from time perspective for various industrial construction projects. Shortage in materials, insufficient drawings, inefficient supervisors, shortage in tools and equipment, staff absence, weak communication, detrimental site layout, inspection delay and rework were found to be the most significant issues affecting project time calendar.

2.6 Factors Affecting Quality in Construction Projects

Quality is defined by (Bamisile, 2004) as the needs of client’s and predictions been formulated into clear measurable requirements for construction projects. The briefing phase demands active co-operation of the clients, the National Economic Development Office (NEDO, 1987) in the United Kingdom emphasized on the importance of keeping clients involved in all stages of any project and providing checklists as a framework for development of the initial brief. Equally important to client in achieving best value in building construction is the process of procurement

and tendering. Allowing sufficient time to prepare comprehensive tender documents and selecting the tenders is one of the key issues that require changes and new ideas.

(Elamah, 2006) further stressed that designer have not matched the advancement and changes in the roles of the client with the same improvement in their own performance. The design objectives and preparing the production information are set to express client demands clearly with measurable terms. Therefore, due to the increased number of people associated with both preparation and usage of production information, there will be increased risks of misunderstanding and oversight.

The quality of coordination of the production information and insufficiencies in production information were recognized by (NEDO, 1985) committee report as some of the factors affecting quality.

2.7 Existing Studies for Time Overrun In the Construction Projects in Iraq and Surrounding Countries

A study has been conducted by T.A. Khaleel (Khaleel, 2017), to discover the major parameters affecting time overrun in construction projects in Iraq. Results for their questionnaire implemented illustrated the major factors that affect time schedule for the projects, the results revealed that forty-two causative factors have been identified as valid and been statistically analyzed by the method of relative importance index. The ranking has been computed by the arithmetic means and the standard deviation. Table (2.1) shows impact ranks based on the importance. Apparently, “Cost increasing, over heads expenses increasing”, Quality degradation”, are most dominant with mean as 4.2, whereas “Poor safety conditions”, has a least importance of impact addressed, with mean as 2.7. The overall result for important time overrun causative factors as shown in Table (2.2). The high rank for time overrun causes and the origin's group of each of these causes. Table (2.3) reveals that the “Contractor's financial difficulties” parameter had the most effective cause among all causes of time overrun with a mean of 4.8. Contractor’s factor was also distinguished as the most common reasons for the appearance of time overrun.

Table 2.1: Ranking of the Effect of Time Overrun

Influences of time overrun	**Mean**	**Standard Deviation**	**Importance ranking**
1- Increasing cost of project (cost overrun)	4.2	0.91894	2
2- Increase in overhead expenses	4.2	0.78881	1
3- Quality degradation	4.2	0.78881	1
4- Productivity degradation	4.1	0.8756	3
5- Loss of firm's reputation (various claims and argument may result in influences on company's notoriety).	3.4	1.26491	5
6- Poor safety conditions.	2.7	0.67495	6
7- Disputes among professionals	3.7	0.94868	4
8- Additional payments for contractor	2.7	1.1595	7

Source: (Khaleel, 2017)

Table 2.2: Ranking for Overall Causes

Overall result	**Mean**	**Rang**	**Origin of time overrun causes**
1- Contractor's financial difficulties	4.8	1	Contractor
2- Shortage of skilled manpower	4.4	2	Contractor
3- Variation of financial situation	4.4	2	Others
4- Weak judgement and experience of the consultants	4.2	3	Consultant
5- Shortage in equipment	4.2	3	Contractor

Source: (Khaleel, 2017)

Finally, very important comments were Proposed to control the time overrun impact, as follows;

1. Carefully select a highly experienced designer to ensure perfect designs.

2. Carry out accurate field investigation prior to design to ensure accurate thorough design details.

3. Make sure to reduce any gap between both design and construction phases in order to avoid future changes of site condition.

4. Make archived finalized, as- built, drawings for every completed project for the

sake of perspective for future projects.

5. Review contract awarding policy (i.e., Evaluation must consider technical with financial related offers laid amidst bidders offering arrangement. Focus must not be paid only on finance in determination criteria).

6. Prepare designs and drawings with thorough details that involve obvious specific details accompanied with acceptable and reasonable plans and timelines.

7. Allowing adequate periods of time for the consultants to review/ revise the designs so as to have certain outlines at the lowest possible modifications.

8. Carefully selection of highly experienced and effective experts in the preparation of project Bill of quantities (B.Q.).

9. Conducted effective and continuous coordination between all stakeholders (i.e., Clients, owner, the consultants, and the contractors).

Another study, conducted by Rasha (Waheeb, 2021), investigated the reasons originating time and cost overruns while selecting 30 reconstruction projects in Iraq, applying case study approach to 30 selected construction projects of various kinds and sizes located in Baghdad city. The Survey field data was implemented to relate statistically both time and cost overrun ratios to delay factors in the investigated construction projects.

Most of the significantly identified delay factors were contractor's failure, repeated revisions of the project design and/ or plan with order variations, safety and security problems, selecting low offer bids, meteorological issues and owner failure.

Fig. (2.2) presents the percentage of significance of the delay factors that cause time overrun. Globally, the most significant delay factors are summarized as; contractor's failure, plans redesign, safety conditions, bids of lower offer, meteorological issues, owner-related issues, variations of site location, delayed laboratory testing, addition of unexpected holidays, failure of consultant engineer, land- related conflicts and other external factors.

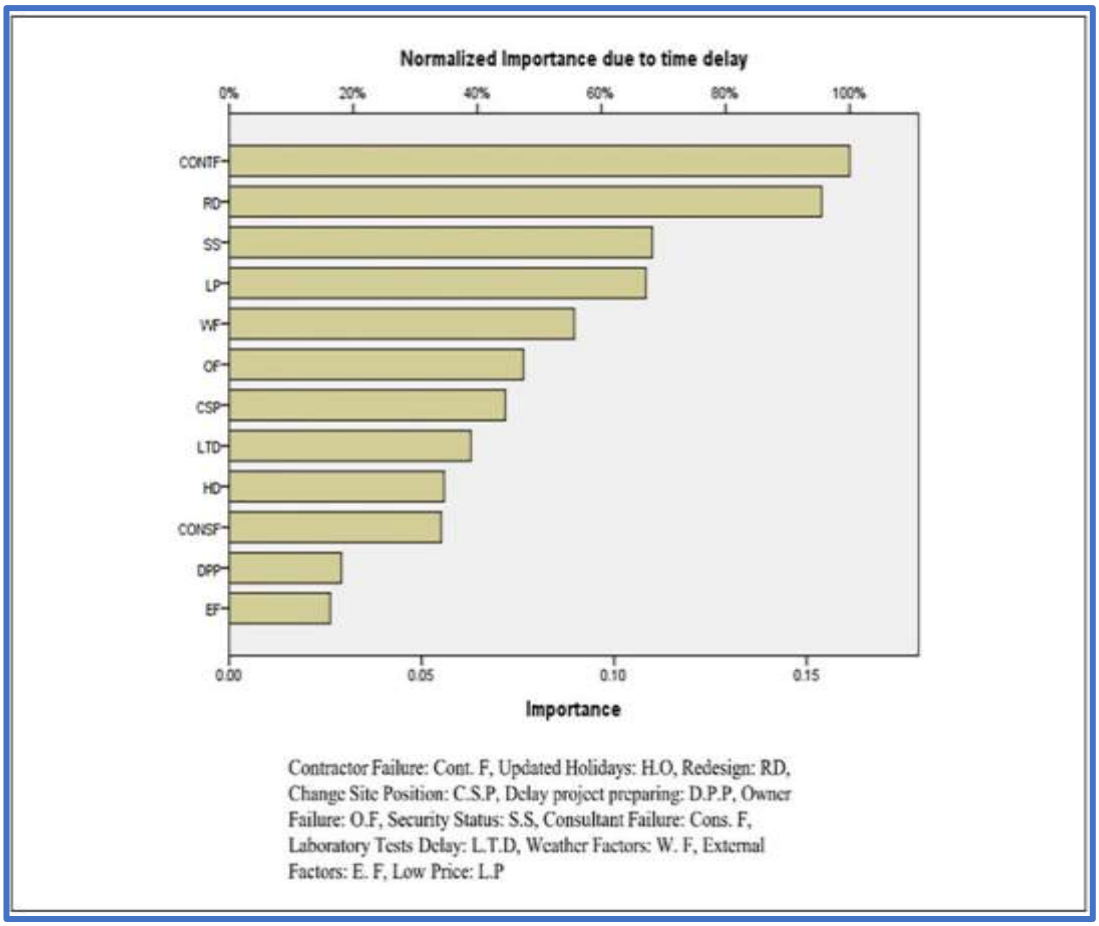


Figure 2.1: Normalized Importance of Causes of Time Overrun

In order to mitigate the problems of time overrun, recommendations were presented as follows;

- In order to avoid issues, a structure for systematic governance have to be established. Systematic revision of rules, laws and legislation for implementing projects in order to exclude any contribution of unqualified companies.
- Cooperating with the private sector for establishing and developing competitively qualified contractors and engineering consultants, by conducting workshops and training sessions for different fields like bidding and implementing better contracts.
- Establish and development of testing laboratories and to be distributed in different provinces and support privet-sector to establish their own laboratories and to be used after got all certification from authority. This will reduce time consumed for testing.

- Lowest-price bid and best value of money selection contractors most advantage to the project owners or client. Therefor there is a need to enhance and review the bidding selection process by using or establish other criteria like (Technical evaluation, Finance capability, Company profile and performance...etc.....).

Sawsan (2015) presented an investigation of the 48 factors that cause time overrun for construction projects in Iraq. Lack of the contractor's financial capacity throughout implementation was found to be the most effective factor among other factors on delay occurrence. This beneficial identification of delay cause factors helps providing database for the decision makers manage times better by adopting effective measures for reducing delays of construction projects. Table (2.3) Presents the of the Means (M), Standard, Deviations (S.D) and Alpha, Cronbach coefficient (α) values of key causes factors of time overrun for construction projects.

Table 2.3: Key Delay Cause Factor Values

Causative Key Factor	**M**	**S.D**	**Alpha**	**Level of Effect**
I- Client-related Delay Factors				
I) Improper financial arrangements.	4.61	0.542	0.95	V. High
2) Payment delays by client to the contractor	4.34	0.794	0.951	V. High
3) Choice of inefficient team for designing	4.32	0.789	0.95	V. High
4) Employer- related stops of work	4.17	0.863	0.95	High
5) Inadequately experienced employer	4.15	0.853	0.9 49	High
6) Design changes done by employers throughout execution stage	3.93	0.787	0.95	High
7) Delivery delay of project site to the contractor.	3.85	0.989	0.95	High
8) Approval delays of design and material specifications	3.78	0.962	0.949	High
9) Inaccurate surveys of project site topography	3.68	0.986	0.95	High
2- Designer- related Delay Factors				
10) Differences between design drawings for all specializations.	4.27	0.742	0.95	Very High
11) A mismatch between the design's drawings and BoQs.	4.17	0.998	0.95	High
12) Inadequately experienced team of design	4.12	0.9	0.949	High
13) Inaccurate of insufficient maps for the underground service network, like piping, wiring, etc.…	4.1	0.97	0.95	High
14) Existence of unimplementable activities due to incorrect prices estimation of BoQ	3.51	0.87	0.95	High
3- Contract- related Delay Factors				
15) Contracting with inadequately competent contractors	4.59	0.706	0.951	Very High
16) Legal arguments between the project- involved parties	3.95	0.835	0.9 49	High

Table 2.3: (Cont.) Key Delay Cause Factor Values

Causative Key Factor	M	S.D	Alpha	Level of Effect
17) Insufficient time paid for preparing the original contract	3.9	0.831	0.95	High
18) Unsuitable choice of the type of delivery contract the project assignment (negotiations, lowest prices, direct invitations, etc.).	3.78	0.962	0.949	High
4- Contractor- related Delay Factors				
19) Financial shortage of the contractor.	4.73	0.449	0.95	Very High
20) Poor management and supervision on site.	4.29	0.68	0.949	Very High
21) Weak project plans and schedules.	4.24	0.734	0.9 49	Very High
22) Repeated changing of subcontractors for their inefficiency at work.	4.1	0.8	0.95	High
23) Repetition of some works due to execution errors.	4.02	0.651	0.949	High
24) Utilization unsuitable and undeveloped construction techniques.	4	0.707	0.949	High
25) Repeated changing in project schedules by contractors	3.88	0.748	0.95	High
26) No risk management plan developed for the project.	3.76	0.799	0.9 49	High
27) Shortage in training and qualifica1ion of the contractor's team.	3.73	0.867	0.949	High
28) Weak relationships between the staff and senior management of the contractor.	3.61	0.891	0.9 49	High
29) Repeated arguments among subcontractors throughout project execution.	3.49	0.978	0.949	High
5·Materials- Re1ated De1ay Factors				
30) Absence of supplies schedule for construction materials.	4.05	0.335	0.95	High
31) Supply of construction materials of non-approved specifications.	4	0.949	0.949	High
32) Shortage in materials either in the market or on site.	3.95	0.865	0.95	High
33) Ignoring important laboratory pre- testing of construction materials prior to usage.	3.8	0.749	0.949	High
34) The replacement of type and specification of materials throughout execution stage.	3.56	0.976	0.949	High
35) Manufacturing process delays of some specialized construction materials.	3.46	0.869	0.949	High
36) Damage of construction materials due to bad storage.	3.44	0.896	0.949	High
6- Equipment- related Delay Factors				
37) Expiry of equipment lifetime.	3.59	0.836	0.949	High
7- Manpower- related Delay Factors				
38) Utilization of unqualified or unskilled labor.	3.98	0.79	0.95	High
39) Utilization of insufficient numbers of labor.	3.83	0.853	0.949	High
40) Scarceness of skilled labor for specific projects due to security issues.	3.63	0.888	0.95	High
8- Others (External) Delay Factors				
41) Appearance of economic issues in the country throughout the execution phase of the project.	4.05	0.893	0.95	High
42) Existence of arguments on the project field.	3.85	0.989	0.949	High
43) Inaccurate soil field testing reports in terms of number and depth of test points.	3.83	0.972	0.95	High

Table 2.3: (Cont.) Key Delay Cause Factor Values

Causative Key Factor	M	S.D	Alpha	Level of Effect
44) Multiplicity of official holidays and unexpected public events.	3.8	0.93	0.951	High
45) Approval- related delays by the officials for working on the project.	3.73	0.975	0.949	High
46) Critical security conditions throughout project execution causes roads shutdown, resulting in unexpected extended project duration.	3.71	0.929	0.95	High
47) Weak communication and coordination between the project parties (employer, contractors, sub-contractors, designers, consultants, employees and suppliers).	3.66	0.938	0.95	High
48) Issuing delays of the laboratory testing results related to the project by the competent authorities.	3.41	0.805	0.95	High

A Study conducted by Qais K. (Jahanger, 2013) concluded that most of engineers agreed that the most significant causes to time overrun are (Mistakes and contradictions of the design documents) according to the relative importance index (RII) technique with a value of 83.05%, and the (Ineffectiveness of the contractor in planning and scheduling the project). Whereas delay causes related to the designing team ranked the highest, replacing the environmental team that ranked the lowest in delay causes. The study proposed that all respondents agreed that the most 10 important time overrun causes in construction projects are listed below:

1. Mistakes and contradictions existing in the design documents.
2. Ineffeciency of the contractor in project planning and scheduling.
3. Weakness of the contractor in managing and supervising the site.
4. Weakness of qualification of the contractor's staff.
5. Unclearness and inadequacy of the drawing details.
6. Inadequatly experienced design staff.
7. Insufficiency of survey and collected data prior to design.
8. Financing difficulties of the contractor to finance the project.
9. Old or improper methods of construction.
10. Poorly qualified labor.

An investigation presented by Hasan and Mohammed (2018) established that 73 causative factors of time overrun of construction projects in Iraq were identified and classified into four categiries; Owner- related factors, Consultant- related factors,

Contractor- related factors and External causes factors.

(Bevian I. Al Hadithi, 2018) investigated the delay cause factors for highway-construction projects in Iraq. Top 7 important cause factors of project time overrun were identified; (1. Political decisions/realities, 2. The country economic crisis, 3. Time overrun in test of materials and/or getting results, 4. Progress payments of contractor not on time, 5. Inability to fix delays in implementation phase, 6. The external factors effects of weather i.e., when raining and/or high temperature, and 7. Slow progress when implementing activities). Finally, his recommendation to establish and development portable laboratories to be adopted in the field.

A study conducted by (Ghanim A. Bekr, 2015) investigated that sixty-five causative factors of time overrun in construction projects in Iraq. Those factors were classified into 4 categories; (Client- related, Contractors- related, Consultants- related and External factors). These factors have been collected via the literature review and the pilot study. The results of research have identified the important factors that cause time overrun for public construction projects in Iraq are; security situation, change of governmental rules and policies, many official and unexpected holidays, using low price- offer bid policy, changes made by owner and/or consultants, owner delay in progressive payments, conflicts with the local society, lack of experience in construction and local economic issues.

H. Al-Jaf and Y. Saeed (2020) conducted a study to discover the most important factors affecting time overrun for construction projects in Iraq. Result of their questionnaire has been identified that the most important top influencing factors ranked were: 12 factors categorized by 4 groups; 6 contractor- related factors, 3 client- related factors, 2 factors to external, and finally 1 factor for consultant.

Another study has been conducted by Awss H. (2019) by assessing sixty-nine factors impacting the performance of construction projects in Iraq. These factors have been categorized into nine groups, using the technique of relative importance index (RII). The overall results show the following:

1. Contractors-factors are the most significantly effective on the project performance with RII equals 83.7.
2. Consultant’s factor ranked next at RII value of 82.9.
3. Resources-factors ranked the third with RII equal to 79.9.

Regarding to the study of Nidal (2021), who investigated 53 causes of low- quality management of construction Projects in Iraq, have been classified to the 8 categories (Equipment, Labor, Systems, Materials, Design and Execution, Sub- contractors, Site staff and Contracts). By using Pareto analysis, the result showed the most significant causes as detailed below;

1. System group =8
2. Design group =7
3. Materials group=5
4. Subcontractors group=3
5. Site staff group=2.

A survey conducted by (Al-Adwani-2018) identified that factors related to the client are mostly important in the delay of construction projects of the public sector in Kuwait. So, clients of those projects were considered as a main responsible side of those delays. Moreover, the absence of application of modern methods of management in the governmental public sector is also one of the reasons behind time overrun in the construction projects of this sector. The weakness in coordination and cooperation among stakeholders, conventional system of procurement and the long approval process are the main causes of this problem. According to the statistical analyses, every factor of every category has been ranked, then determination of top-ranked factors in each category have been conducted. Table (2.4) shows factors of the highest ranks of each category.

Table 2.4: Delay Factors of the Highest Ranks in the Construction Projects in Kuwait

Category/ group title	**Delay factors**
Factors related to clients	1. Approval delays and delayed decisions made.
	2. Fail of coordination of the owner with the official authorities throughout planning phase.
	3. issues of the client's tendering system that requires selection of the lowest bidder.
	4. Revision and approval delays for the design documentation.
	5. Repeated changes in decisions.

Table 2.4: Delay Factors of the Highest Ranks in the Construction Projects in Kuwait

Category/ group title	**Delay factors**
Factors related to contractor	1. Arguments between contractors and their subcontractors.
	2. Delays of subcontractors' works.
	3. The contractor has ineffective quality control.
	4. The head office of the contractor is inefficiently involved in the project field.
	5. The contractor's ineffectiveness in planning and scheduling the project.
	6. Contractor delays in the preparation submissions.
Factors related to consultant	1. Delayed approval of the main changes of the work scope.
	2. Arguments between consultants and design team.
	3. Delayed review and approval of the design documentation.
Factors related to contract	1. Contradictions and mistakes in the design documentation.
	2. Mismatch between owner requirements and designers' thoughts
	3. Weak and ineffective penalties for the delay
Factors related to contractual relationships	Poor communication and compromise between parties
Factors related to Manpower	1. Unexperienced labor
	2. The procrastination level of the labor
	3. Lack in necessary equipment
Factors related to Materials	1. Escalated prices of materials.
	2. Altering of types and specifications of materials.
	3. Delays of special building materials manufacture.
Factors related to external causes	1. Delayed extraction of municipal permissions.
	2. Hard climatic situations in the field.
	3. Delayed provision of services for the utilities like water and electricity.

Source: Ibrahim (2013).

Based on the Relative Importance Index (RII) criterion, the global ranking of 15 highest factors was conducted. The results for the top 15-time overrun factors are

shown in table (2.5). Finally, to mitigate the time overrun of construction projects, the government should adopt a mitigation strategy plan applied to construction projects in the public sector. Since government is the main motive of public sector, needs to improvement must be a major priority to treat such issues.

Table 2.5: Presents Top 15-Time Overrun Factors

Group No.	Delay Factor	Related factor
1	Delayed approvals and decisions	Client
2	Delayed extraction of municipal permissions	External
3	Weakness of owner coordination with authorities throughout planning phase	Client
4	Traditional tendering system of client that requires selection of the lowest bidder	Client
5	Delayed revision and approval of the design documentation	Client
6	Repeated decision changes	Client
7	Tough climatic situations on the field	External
8	Delayed approval of material samples	Client
9	Inefficient labor	Manpower
10	Communication outage of the client with the relevant official authorities	Client
11	Delayed charge orders issuance from the client	Client
12	Contradictions and errors of the design documents	Contract
13	Escalated prices of materials	Materials
14	Delayed settlement of claims by the owner	Client
15	Arguments between the contractors and their subcontractors	Contractor

Source: (Al-Adwani-2018).

Ibrahim (2013) investigated the contributing factors to schedule delays for public construction projects of Saudi Arabia. The result of the implemented questionnaire identified thirty-five contributing factors through a survey of literature. Results elucidated that top delay c contributing factors are bid award for lowest price, weak site management, weak communication and coordination among construction parties, delayed payments, labor procrastination, and repeated works. Drawn Results assist in implementation time improvement for construction projects in the public sector of Saudi Arabia and other developing countries. Finally, a list of recommendations was set to mitigate and control time overrun in public construction projects:

1. Conducting capacity building via training course and workshops to improve the technical skills of the construction partners (i.e., Clients; Contractors, technical staff, etc.).
2. Conducted effective and continuous communication and coordination among

all construction partners throughout design, planning and execution of the project phases.

3. In order to prevent a wide use of lowest price bid selection, bids should be awarded to the bidder with reasonable estimation of costs.
4. Progress payments must be paid by the clients/ customer to the contractor on schedule, since it significantly affects the contractor's financial capacity.
5. Thorough and careful site examination have to be conducted prior to the design stage to avoid future changes throughout the construction stage. Eventually, reworks will be controlled.
6. Authorities must review/revise Laws/Regulations taking into consideration conditions for raising fees and benefits of the labor. This enhances and motivates the labor towards more efforts and increases their productivity.

A study has been conducted by (Gündüz, 2013), eighty-three-time overrun factors classified to the 9 main groups. These are the most significant through ranking results by using Relative-Importance-Index (RII) technique.

A study carried-out by Ghada T. et.al. (2016) by assessing sixty-three overrun time factors have been categorized by 10 groups. The analysis of the results showed the significant effects of 5 delay factors on the construction projects:

1. Client-Progress payments delay.
2. Contractor-Poor site supervision and management.
3. Contractor-Lack in skilled and qualified labors.
4. Contractor-Financing project difficulties.
5. Contractor-Bad planning and scheduling of project.

A study has been conducted by Hassan E. et.al (2015) to exploring the contributor factors in time overrun of infrastructure construction projects in Qatar. Results show that over 80% of infrastructure construction projects suffer time overrun issues with 25% average delays. The most significant contributor factors were suggested as:

1. Time delayed responses by the utility agencies.
1. Crucial changing of designs throughout construction phase.
2. Inactive scheduling and planning.
3. Inactive progress control

4. Changing of project scope.

Ahmed Y. et al. (2017) conducted an investigation study for the key causing factors of time overruns, cost, and quality of highway construction projects through a literature survey and questionnaire- based field survey in Egypt. Their results confirmed the prevalence of delayed schedules, cost overrun, and drop of quality. The following cause factors were sorted as the most common and severe:

1. Lack in skilled and qualified labors.
2. Shortage in coordination and communication among all construction partners.
3. Insufficient and ineligible technical staff.

A study conducted by A. R. S. Sri Susmitha et.al (2018) investigated those twenty-one causative factors impacting the timeline of residential construction projects were identified and grouped into nine categories. These factors have been collected via the literature review and the pilot study.

On a rank- based criteria, the following causes of time overrun were considered as major causes;

1. Escalated materials prices.
2. Shortage in labors.
3. Weather Conditions.
4. Lack in skilled and qualified operators.

A study conducted by Ammar Z. et.al (2018) investigated those forty-eight causative factors twenty-six related to time overrun and twenty-two factors related to cost overruns respectively and categorized into nine groups. Implementation of the Relative-Importance-Index (RII) method revealed that the 5 most important cause factors of time overrun are;

1. High Labor productivity.
2. Lack of data collection before design.
3. High labor motivation.
4. Regular progress payment flow during construction,
5. Supply material on time.

And the 5 most important factors causing cost overruns are

1. Re-work.
2. Price fluctuation.

1. Increasing of material price.
2. Extra work request by owner.
3. Increasing in the cost of shipping/transportation.

So that there is an urgent need to pay attention and concentration on those factors to prevent time and cost overruns that of sure affecting the quality.

A study conducted by Leena M., A. Warudkar (2016) investigated that 83 causative factors of time overrun of construction projects in India. The factors were classified into 9 categories. With regards to the questionnaire results, the most important causative factors are:

1. Price fluctuation.
2. Time Delays for provision of work teams.
3. Shortage in labors.
4. Shortage in using high technology equipment.
5. Shortage in qualified labors.

2.8 The Summary Common Group Factors of Time Overrun in the Previous Studies

In summary, the literatures categorized causative factors of time overrun in construction according to the categories listed table (2.6).

Table 2.6: Categorization of the Causative Factors of Delay by the Literature

References	**Project**	**Contract**	**Financial**	**Design**	**Owner**	**Client**	**Consultant**	**Designer**	**Contractor**	**Sub-contractor**	**Materials**	**Equipment**	**Manpower**	**Environment**	**External**
(Murali S.,2006)		√				√	√		√		√	√			√
(Muya, M., Kaliba, 2013)			√			√	√		√						√
T.A.Khaleel (2017)							√		√						
Rasha A. Waheeb (2021)					√		√		√						√
Sawsan R. (M., 2015)		√				√		√	√		√	√	√		√
Qais K. Jahanger (2013)	√			√	√		√		√		√	√	√	√	√

Table 2.6: (Cont.) Categorization of the Causative Factors of Delay by the Literature

References	Project	Contract	Financial	Design	Owner	Client	Consultant	Designer	Contractor	Sub-contractor	Materials	Equipment	Manpower	Environment	External
M. F. Hasan, and M. S. Mohammed (2018)					√		√		√						√
(Bevian I. Al Hadithi, 2018)					√		√		√		√	√	√		√
(Ghanim A. Bekr-2015)						√	√		√						√
H. Al-Jaf and Y. SAEED (2020)						√	√		√						√
Awss H. (2019)			√		√	√	√		√		√	√	√		√
Nidal (2021)		√		√					√	√	√	√	√		
(Al-Adwani, 2018)		√				√	√		√		√		√		√
(Ibrahim M. 2013)		√		√		√	√		√		√		√		
(Murat Gündüz, 2013)	√			√	√		√		√		√	√	√		√
Ghada T. et.al.(2016)	√	√			√		√		√	√	√	√	√		√
Hassan E. et.al (2015)						√	√		√						√
Ahmed Y. et al.(2017)					√		√		√		√	√			
A. R. S. Sri Susmitha et.al (2018)	√			√	√		√		√		√	√	√		√
Ammar Z.et.al(2019)			√	√	√	√	√		√		√	√	√		
Leena M,, A. Warudkar (2016)	√					√	√	√	√		√	√	√		√

2.9 Research gap

The survey of the open literature reveals that most researches analyze time overrun cause factors in construction projects in Iraq and other surrounding countries in the middle- east region; suffers a research gap in the study of the relation of time overrun and management control and quality. In the present research, the data gathered via a questionnaire- based field survey are to be analyzed to identify the impact factors of construction project duration and management process of water construction projects in Baghdad city of Iraq.

2.10 Research Methodology

The methodology of the present work consists of the following stages:

- Identification of impact factors of construction project duration and management process by conducting a survey of the open literature and through specialized personnel in the ministries including specialists and expert engineers and contractors.
- Making benefits from previous studies, field- based survey questionnaires are designed and prepared.
- Online survey questionnaire and conducting personal meetings with specialists, experts from engineers and contractors.
- Analysis of questionnaires.
- Provision of practical comments and recommendations that help upgrade and improve the performance of water projects.
- Draw conclusions and set recommendations for future investigations.

2.11 Interviews with Experts

Due to the current situation of COVID-19, personal interviews has been conducted with different groups of expert and specialist engineers working in the water and sanitation sector especially in the management, planning, design and execution of the construction and rehabilitation fields of water projects in the related departments of the Iraqi governmental authorities along with the public sector ministries (Ministry of municipalities and public works, Mayoralty of Baghdad, water directorate) and UN agencies (i.e., UNICEF and UNHCR). The interview was conducted via Skype and Microsoft team software. The aim of these interviews was to gather more information about the effect of project duration on management control and quality in Iraq.

Below a sample of list of interviews with invitees staff:

	Name	**Position**
	Entity	
1-	Dr. Ali Al-Khateeb	Chief WASH UNICEF (Water and Sanitation, Hygiene)
2-	Eng. Ali Auob UNICEF	WASH Manager
3-	Eng. Hussein Al-Azzawi	WASH Specialist UNICEF
4-	Eng. Bassam Al Bayati	WASH Officer UNICEF
5-	Eng. Waleed Ahmed	WASH Officer UNHCR
6-	Dr. Hassan Naji	Manager Ministry of Science and Technology
7-	Eng. Omar M. Saleh	Manager Ministry of Construction and Housing and Municipalities Public
8-	Eng. Ammar M.	Manager Mayorly of Baghdad-Baghdad Water Authority
9-	Eng. Abbas I. Ali	Manager Kirkuk Water directorate
10-	Eng. Emad Al-Jarallah	WASH Consultant WHO (World Health Organization)

2.12 Survey questionnaires design

The survey questionnaires had big interest since it depends on the experience of employees that has offered by specialists in the Ministry of municipalities and public works, Ministries of Housing and Construction and Public Works, UNICEF and UNHCR specialists in water sectors.

2.13 Data processing and Statistical analysis:

Microsoft Excel is used as a statistical tool to produce output tables and statistical analyses by formulating statistical equations in excel.

2.14 Data analysis and Implementation

Starting with results of previous works, especially in Iraq and the neighbor countries, a list of factors is developed, that may impact the duration of water projects in Iraq and is grouped into five main categories. A questionnaire is developed to evaluate the frequency of occurrence and importance of the identified factors. The questionnaire form contains (40) causative factors that have been categorized into five origins groups that are previously identified. The sample size (N) consisted of (122) forms after incorrect forms being excluded, the specialization field, participants' work sector, type of projects they are involved in, and work experience are given in Figs. (3.2.1, 3.2.2, and 3.2.4) respectively. A Likert scale "five-point scale" is implemented, which was also implemented by others (Ramachandra and Rotimi, 2015 and Gunduz and Abu Hassan, 2017 and reformed to the relative index method for all causing factors to elucidate the rankings of various factors "(1-Very Low, 2- Low, 3- Moderate, 4- High, 5-Very high)" in collecting respondents' answers, and Microsoft Excel software has been utilized in performing the statistical analyses of the collected data by computing the arithmetic means and standard deviations using equations (1) and (2) shown below. The assessment has been conducted using online google form due to the current situation of COVID-19 to assess the impact factors of construction project duration and management process. Furthermore, to compute the value of Alpha Cronbach's coefficient (α) Lauren, (2022) that indicates the level of consistency of the scale. When high value of the Alpha Cronbach's coefficient (α) (approximately 1) appears, this elucidates the reliability of the questionnaires, and the coefficient of Cronbach Alpha is presumed not less than 0.7. The M, SD and Cronbach's coefficient (α) are calculated by the following equations.

$$M = \frac{\sum_{i=1}^{k}(x_i \times f_i)}{n} \qquad \textbf{(2.1)}$$

$$S.D = [(\sum_{i=1}^{k}((x_i - M))^2 \times f_i] / \sum_{i=1}^{k} f_i \quad \textbf{(2.2)}$$

$$Cronbach\ (\propto) = \left[\frac{k}{k-1}\right] \times \left[1 - \frac{\Sigma s_i^2}{S_{sum}^2}\right] \quad \textbf{(2.3)}$$

Where:

M= Mean.

SD= Standard deviation.

Xi= Weight Value for particular. (According to likert scale from 1 (very low) to 5 (very high))

Fi= Frequencies number.

N= Total of respondents.

Si= Respondents current sample Variance.

K=Total of factors number.

Ssum=Summation of variance for all respondents.

Cronbach's alpha ranges according to Liyin Shen, 2011

Excellent: α greater than or equals 0.9

Good: α between 0.7 and 0.9

Acceptable: α between 0.6 and 0.7

Poor: α between 0.5 and 0.6

Unacceptable: α less than 0.5

2.15 Summary

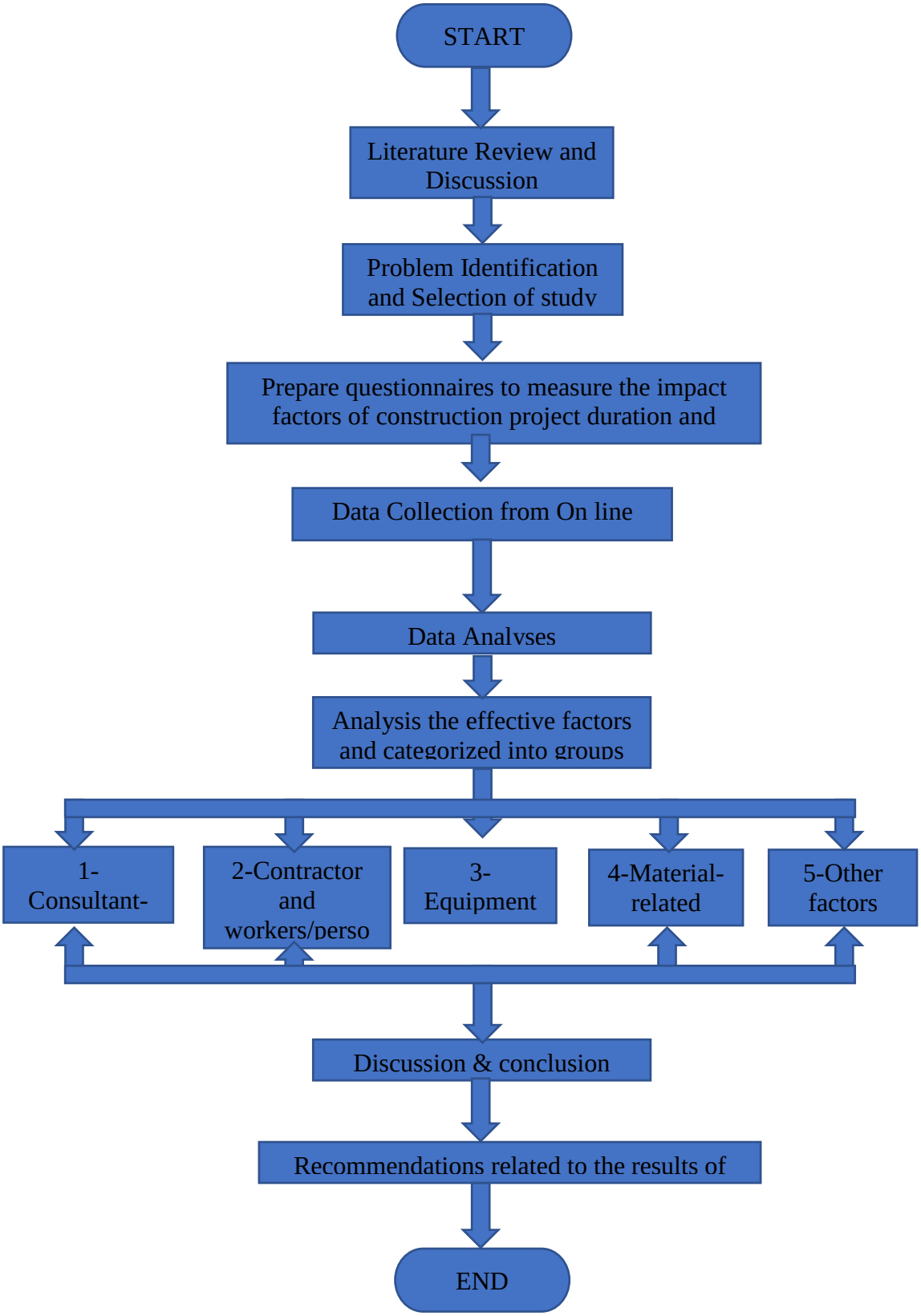


Figure 2.2: Flow Chart Shows Research Methodology

In summary, an algorithm flowchart fig. (2.3) shows the research methodology of the study.

2.16 Questionaries Form

Fig. (2.4) shows a sample of the questionnaire adopted in the present investigation. To ensure the highest possible accuracy of results, different levels of participants' age, position, level of education work sector, experience and type of construction project they work in. the questionnaire also takes into consideration the opinion of the consultants and contractors about the variety of the project factors.

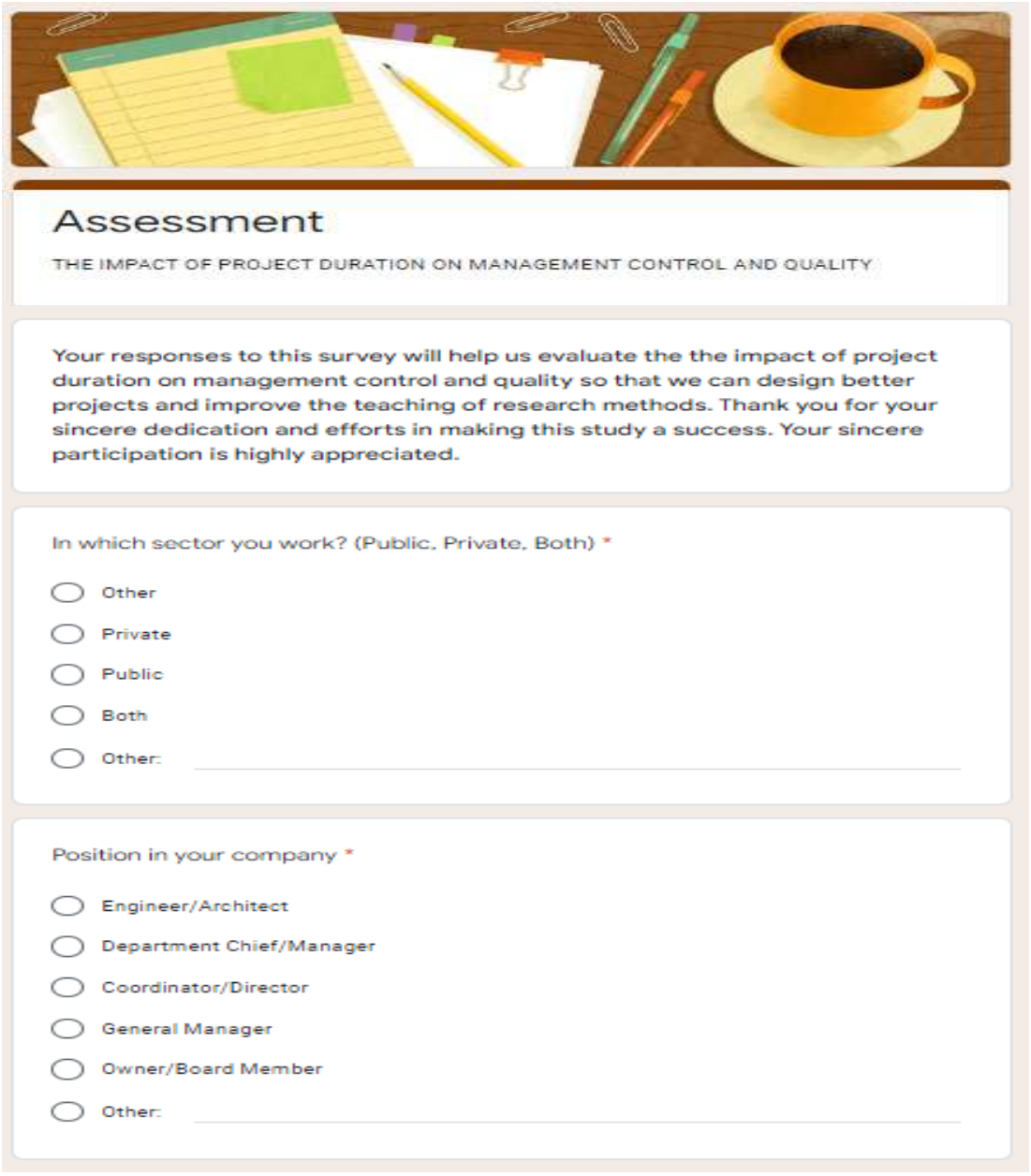
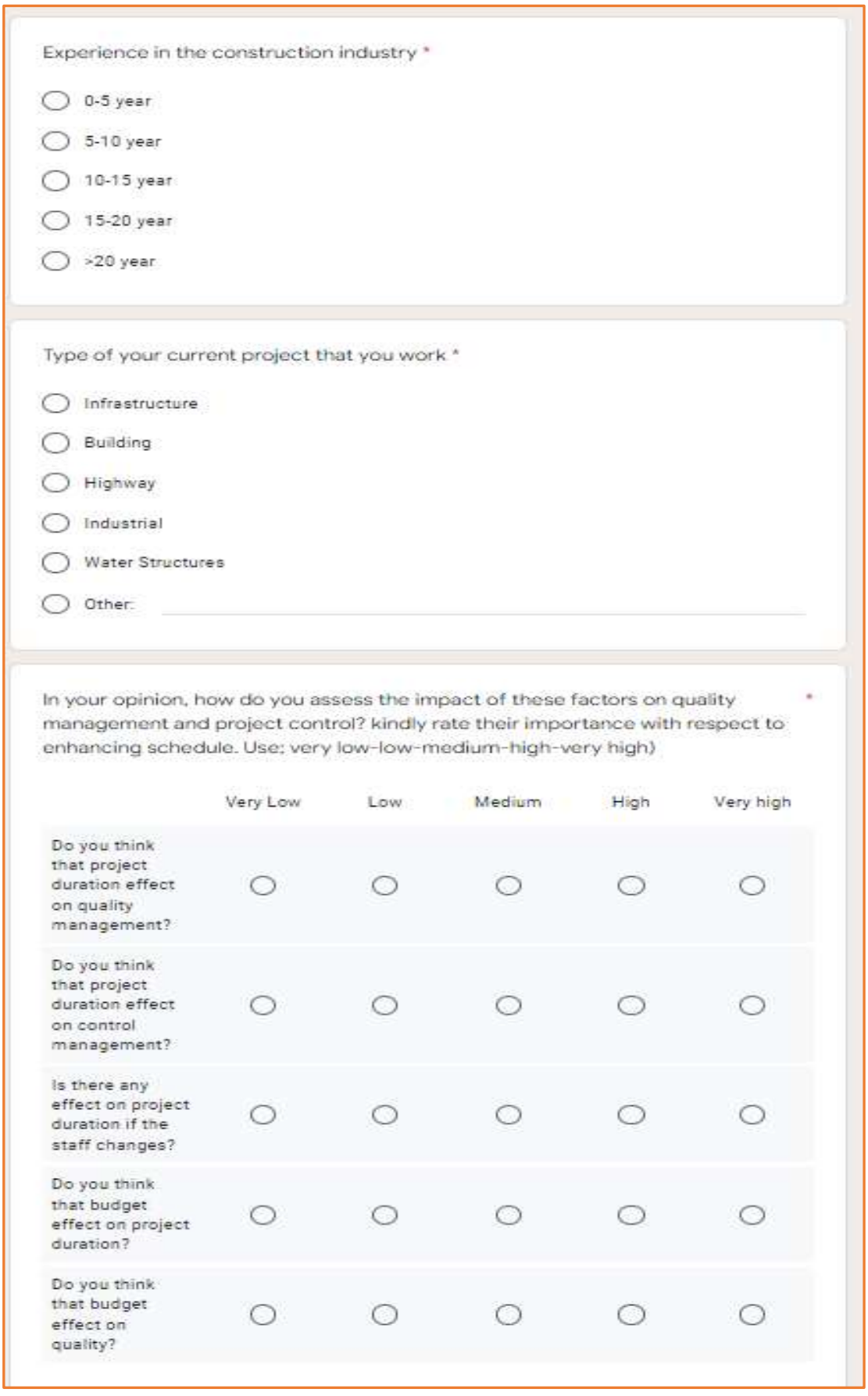


Figure 2.3: Sample of the Questionnaire Adopted in the Present Research


Experience in the construction industry *

- 0-5 year
- 5-10 year
- 10-15 year
- 15-20 year
- >20 year

Type of your current project that you work *

- Infrastructure
- Building
- Highway
- Industrial
- Water Structures
- Other:

In your opinion, how do you assess the impact of these factors on quality management and project control? kindly rate their importance with respect to enhancing schedule. Use: very low-low-medium-high-very high) *

	Very Low	Low	Medium	High	Very high
Do you think that project duration effect on quality management?	○	○	○	○	○
Do you think that project duration effect on control management?	○	○	○	○	○
Is there any effect on project duration if the staff changes?	○	○	○	○	○
Do you think that budget effect on project duration?	○	○	○	○	○
Do you think that budget effect on quality?	○	○	○	○	○

Figure 2.3: (Cont.) Sample of the Questionnaire Adopted in the Present Research

Consultant Factors *

	Very Low	Low	Medium	High	Very high
Delay in approving major changes in the scope of work.	○	○	○	○	○
Poor communication and coordination.	○	○	○	○	○
Inadequate experience of consultant.	○	○	○	○	○
Mistakes and discrepancies in design documents.	○	○	○	○	○
Unclear and inadequate details in term of reference and/or drawings.	○	○	○	○	○
Insufficient data collection and survey before design.	○	○	○	○	○
Lack of advanced engineering design software.	○	○	○	○	○
Conflicts between consultant and design engineer/contractors.	○	○	○	○	○
Preparation and approval of drawings.	○	○	○	○	○

Figure 2.3: (Cont.) Sample of the Questionnaire Adopted in the Present Research

Contractor and workers/personnel related *

	Very Low	Low	Medium	High	Very high
Shortage of unskilled & skilled labor.	○	○	○	○	○
Personal conflicts among workers.	○	○	○	○	○
Lack of incentives for contractor to finish ahead of schedule.	○	○	○	○	○
Rework due to errors during construction.	○	○	○	○	○
Conflicts between contractor and other parties.	○	○	○	○	○
Poor communication and coordination.	○	○	○	○	○
Improper construction methods implement.	○	○	○	○	○
Frequent change of sub-contractors.	○	○	○	○	○
Delays in site mobilization.	○	○	○	○	○

Figure 2.3: (Cont.) Sample of the Questionnaire Adopted in the Present Research

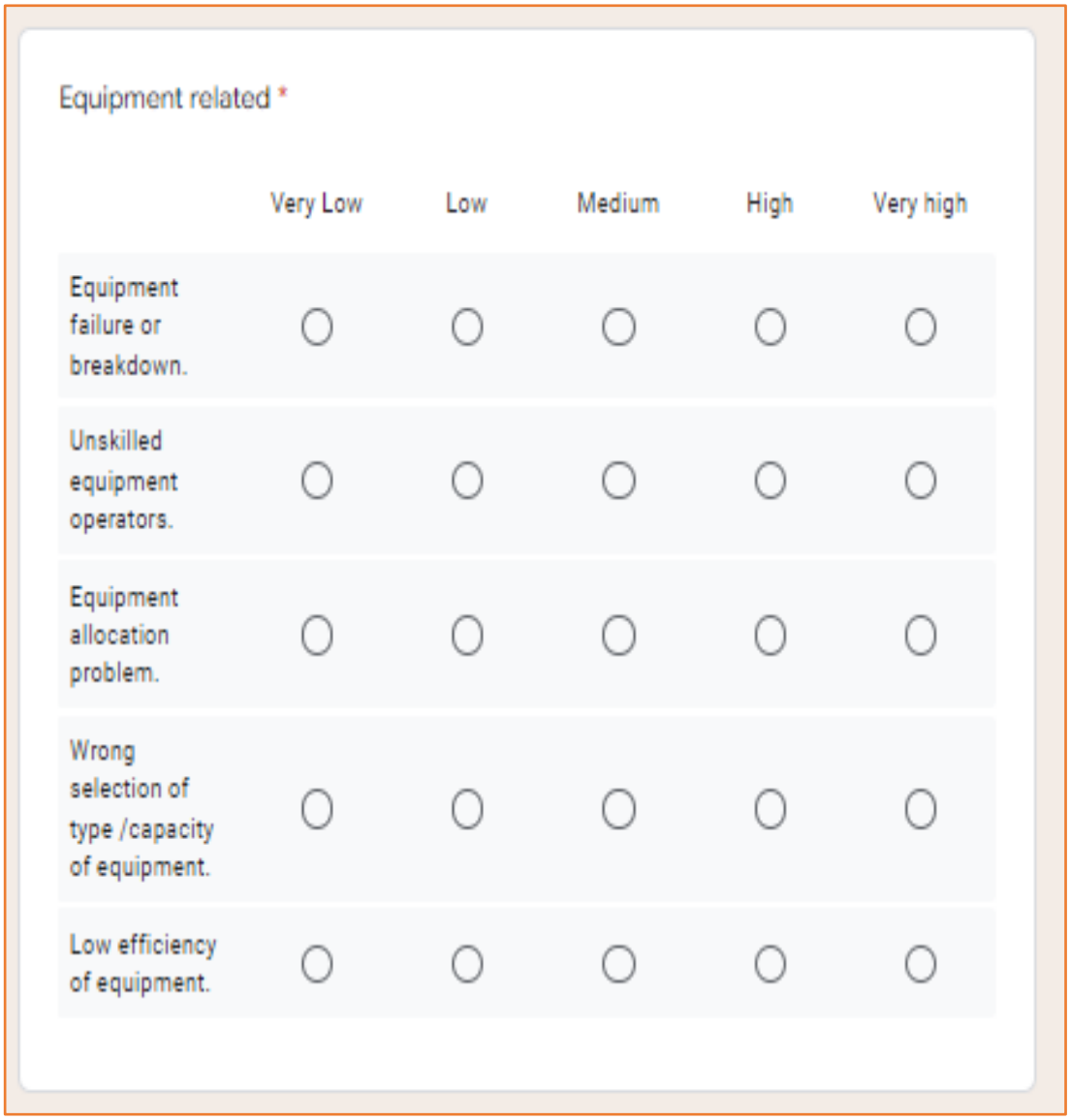


Figure 2.3: (Cont.) Sample of the Questionnaire Adopted in the Present Research

Material related *

	Very Low	Low	Medium	High	Very high
Shortage of construction materials in market.	○	○	○	○	○
Delay in material delivery.	○	○	○	○	○
Damage of sorted material.	○	○	○	○	○
Changes in material types and specifications during construction.	○	○	○	○	○
Escalation of material prices.	○	○	○	○	○
Poor quality of construction materials.	○	○	○	○	○
Poor planning of supply plan for materials.	○	○	○	○	○
Receiving materials that do not fulfill project requirements.	○	○	○	○	○

Figure 2.3: (Cont.) Sample of the Questionnaire Adopted in the Present Research

Other factors related *

	Very Low	Low	Medium	High	Very high
Accidents during construction.	○	○	○	○	○
Underestimation of time of completion.	○	○	○	○	○
Geological problems on site.	○	○	○	○	○
Poor site management &Inaccurate site investigation.	○	○	○	○	○
Application of safety aspect.	○	○	○	○	○
Delay in obtaining permits from municipality.	○	○	○	○	○
Delay in providing services from utilities (water, electricity, etc.).	○	○	○	○	○
Complexity of project (project type, project scale, etc.).	○	○	○	○	○
Legal disputes between project participants.	○	○	○	○	○

Figure 2.3: (Cont.) Sample of the Questionnaire Adopted in the Present Research

Below is a list of proactive steps for avoid or reduce water projects delay. kindly rate their importance with respect to enhancing schedule. Please evaluate the effectiveness of proactive steps given below on the quality management and project control and Use; very low-low-medium-high-very high) *

	Very Low	Low	Medium	High	Very high
Frequent progress meeting.	○	○	○	○	○
Use up-to-date technology infrastructure.	○	○	○	○	○
Use proper and modern construction equipment.	○	○	○	○	○
Use appropriate construction methods.	○	○	○	○	○
Hire skilled personnel (workers and engineers)	○	○	○	○	○
Effective strategic/risk planning.	○	○	○	○	○
Proper material procurement.	○	○	○	○	○
Accurate initial cost estimates.	○	○	○	○	○
Monitoring the construction process	○	○	○	○	○
Proper project planning and scheduling.	○	○	○	○	○
Complete and proper design at the right time.	○	○	○	○	○
Site management and supervision.	○	○	○	○	○
Safety precautions	○	○	○	○	○

Figure 2.3: (Cont.) Sample of the Questionnaire Adopted in the Present Research

3. DISCUSSION OF RESULTS

3.1 Introduction

The results and findings from the collected survey questionnaire data of the present research are discussed in this chapter for the impact factors of construction project duration and management process. Furthermore, this chapter provides the analysis of data collected by a questionnaire that present the major factor that effect on the quality and control management especially with regard to project duration. Also, all this data was collected by experts in the field of construction, based on their experience in their respective field. The results of this research show us the solutions that must be taken in the planning stage, and they include the most prominent influences that lead to improvement and quality of work.

3.2 Data Description and Representative

All data in this study represent by 122 Iraqi experts, specialists from engineers in construction from different sectors, who respond to the survey conducted by questionnaire to the main construction project expert in Iraq. Those participants have a different role in the construction field, they are represented by client, consultant, and contractor. Furthermore, they are working in various sectors like public sector, private sector, and combination of both sectors. Total number of surveyed experts 122 who respond to the survey as we can see from the fig. (3.1) below shows the assessment timeline that has been started on 23 July 2021 and closed on 8 September 2021.

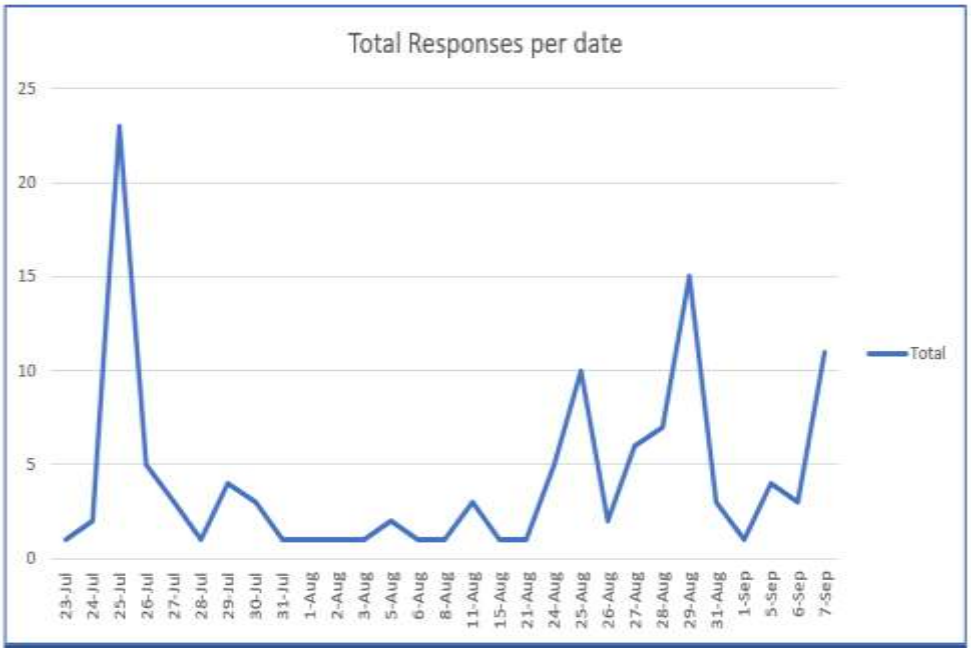


Figure 3.1: Shows Total No of Responses Time

3.2.1 Respondents work sector

Fig. (3.2) Shows the percentage sample of the study according to the work Sector, 48 % of the respondents working in public sector, 26% are working in the private sector, more over 16% of the respondents are working in other's sector (i.e., UN agencies) finally 9% are working in both sectors (public and private).

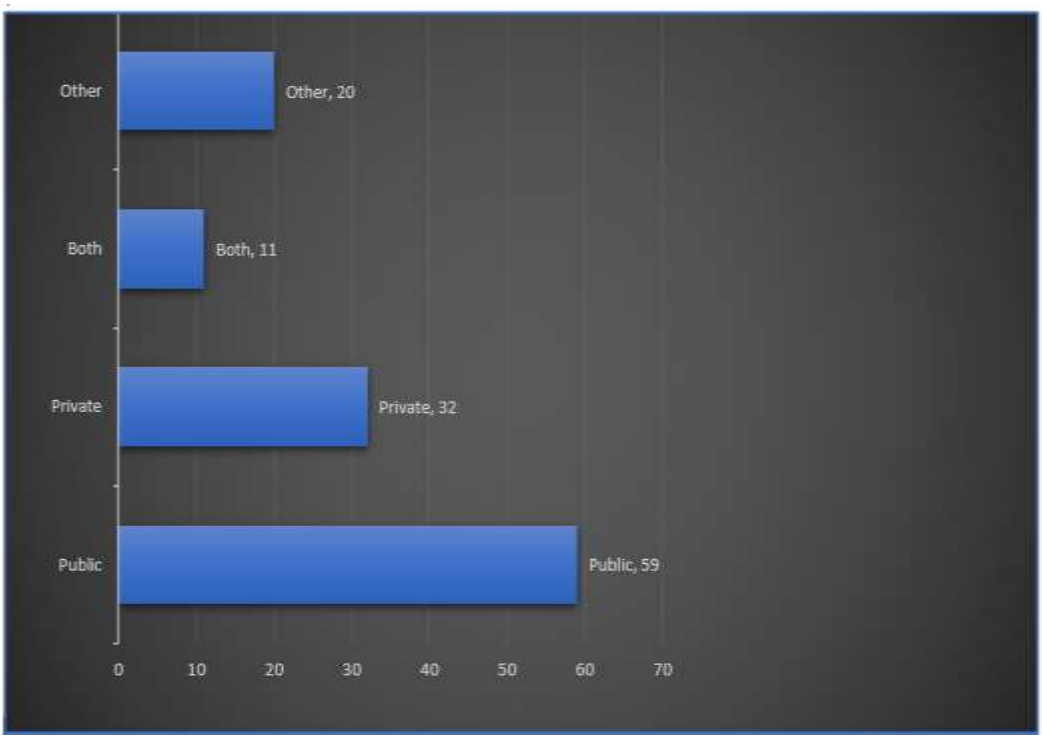


Figure 3.2: Shows Total No of Responses Work Sector

3.2.2 The Type of current project that respondents work

Fig. (3.3) depicts information about the type of projects they are involved in. The case study is decided on the number of the technical staff, as follows: 48% is in Building projects, 17% Infrastructure, 15% Water Structures, 9% Industrial, 7% Highway finally 4% Others.

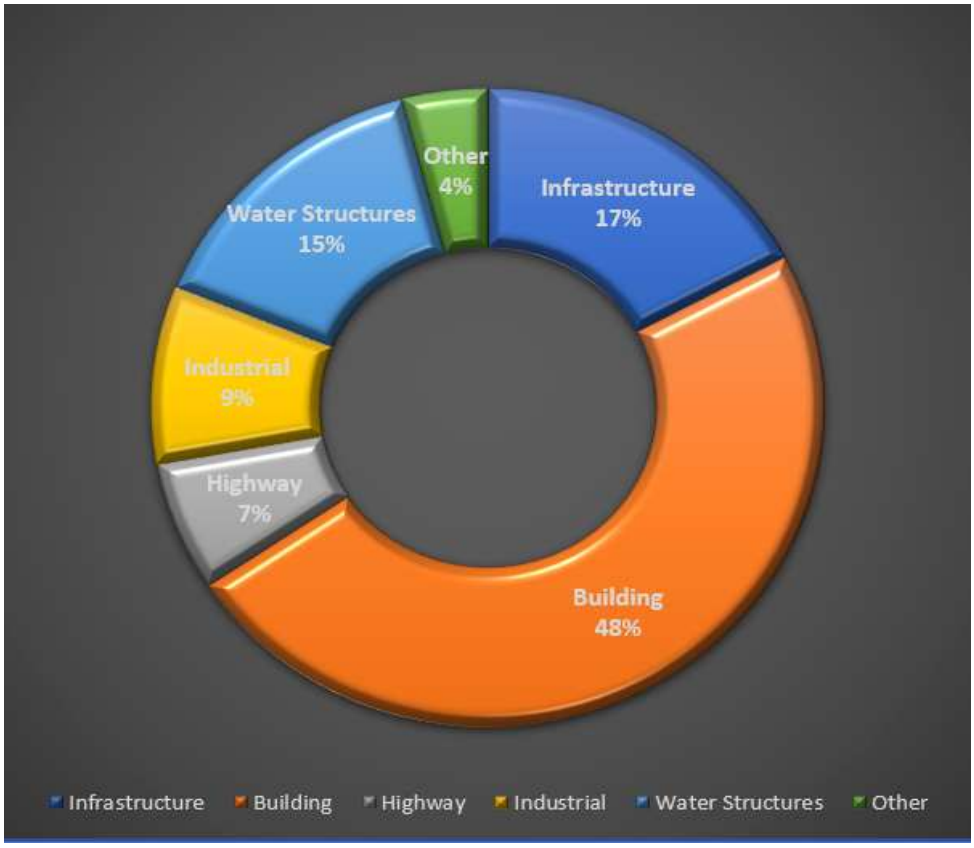


Figure 3.3: Shows the Type of Current Project That Respondents Work

3.2.3 Respondent's position/titles in company

The analyses that follow in this work emphasizes on the 122 respondents who filled the entire questionnaire forms and implicated to one of the categories targeted by the investigation. As illustrated in Table (3.1), respondents to the survey are Engineer/Architect (80%), Department Chief/Manager (14%) and General Manager, Other staff (2%), Coordinator/Director (1%).

Table 3.1: Shows the Grouping of Respondents According to Job Position

Position	Total No. of Respondents	Percent
Engineer/Architect	98	80%
Department Chief/Manager	17	14%
General Manager	3	2%
Coordinator/Director	1	1%
Owner/Board Member	0	0%
Other	3	2%
Total	122	

3.2.4 The experience years for the respondents

Fig. (3.4), shows that 25% of respondents have a working experience of 15-20 years, 22% of the respondents who have working experience of 10-15 years, 19% of respondents have 0-5 years of experience, 17% experience of 5-10 years and 16% of the respondents have more than 20 years' experience.

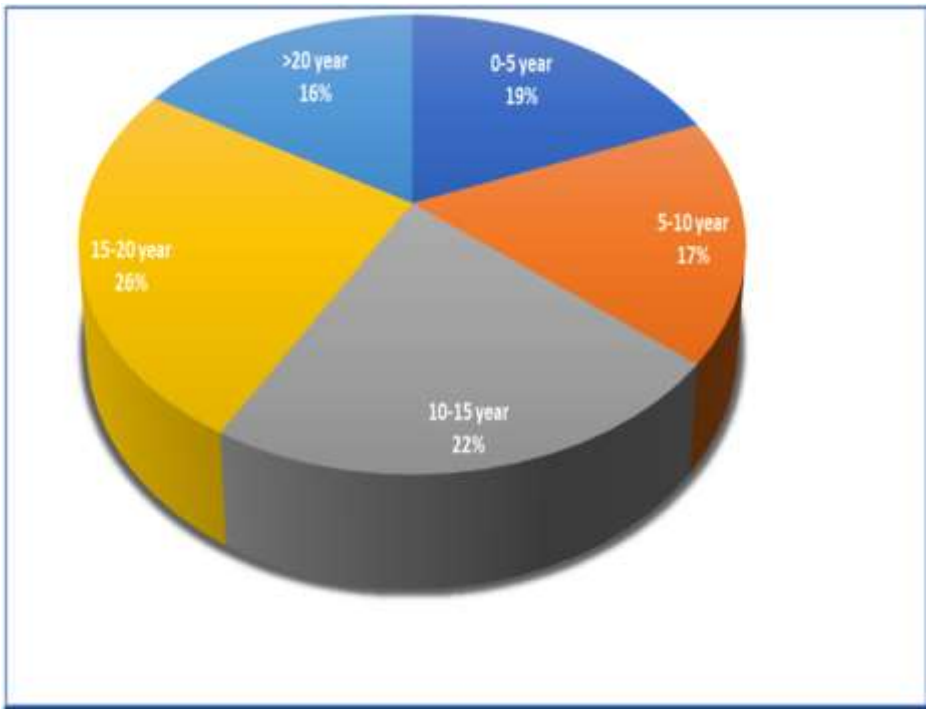


Figure 3.4: The Percentage of with Respect to Experience

3.2.5 Respondents to Factors Affecting Quality Management and Project Control

According to what is shown in the questionnaire, fig. (3.5) shows the impact of each of these factors on project duration and management process, while these statistics represent the participants point of view based on their experience in the field of construction.

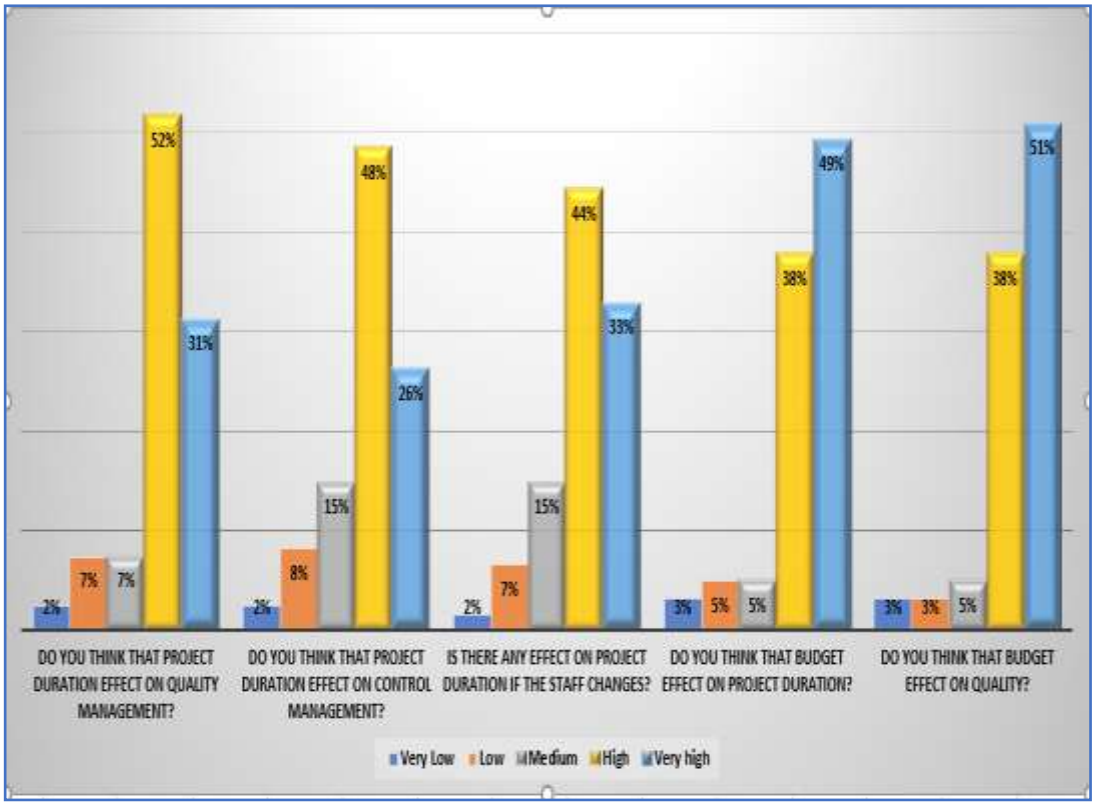


Figure 3.5: Shows respondents for factors that affecting on project duration and management process

3.2.5.1 Effect of project duration on quality management

Based on the rank that is shown in fig. (3.5), the highest percentages have been distributed between the high and very high ratings, and this clarifies the importance of project duration in affecting negatively or positively on quality management. As the evaluation for the high impact rate represents 52 percent, and the evaluation for the very high rate represents 31percent. Furthermore, a small percentage of the participants in the questionnaire saw that the importance of the project duration affects medium or low on quality management, as their evaluation rate was medium or low and constitute an equal percentage, as each represents 7 percent. In return the lowest percentage represented the participants who considered that the duration of the project has a very low impact, and this percentage represents only 2%.

3.2.5.2 The effect of project duration on control management

Referring to fig. (3.5), the result of questionnaire analysis explains that project duration has high effect on control management, this result was based on what experts encountered in the construction field. Which is represent 48 percent. While some of them believe that the duration of the project is very high on the control

management, and these experts represent a proportion of 26 percent. Also, about 15 percent give a medium impact estimation of the project duration on the control management. Furthermore, 10 percent represents the sum of two ratings, which included 8 percent for the low rank and 2% for very low effect on control management.

3.2.5.3 The effect of changing staff on the duration of projects

Based on the results obtained from the questionnaire, it is obvious that changing the staff has a significant impact on the project duration. So, this change may positively or negatively effect on the duration of the project, while it depends mainly on the extent of the workers experience and their prior implementation of similar projects. As shown in fig. (3.5), the highest percentage of participants gave a high evaluation on the change of the staff and the extent to which the length of the project affected by it, where it represented a percentage of 44 percent. Otherwise, the percentage of those who find that the effect of changing the staff very high impact on project duration represent 33 percent. Also, about 15 percent of respondents think that change of staff has a medium effect based on statistics. In return nine percent consist of two classifications: first one is the low effect which represents seven percent, and the second one of very low effect represents only two percent.

3.2.5.4 Effect of budget on project duration

As shown in fig. (3.5), the highest percentage of respondents in the survey had their choices ranging between high and very high. Which clarifies the importance of the budget's influence on the project duration in terms of cash flow. Where 38 percent represents the high evaluation, and 49 percent represents the very high evaluation. While the medium and low rating were 5 percent for each. Otherwise, the remaining 3 percent represented very low evaluation.

3.2.5.5 Effect of budget on quality

According to the statistics shown in fig. (3.5), the impact of the budget on quality is very high, as it constituted a percentage more than half, estimated at 51 percent. While the participants who were of the opinion that the budget effect on quality is within the high evaluation, their percentage is 38 percent. On the other hand, 11 percent included 5 percent for the medium evaluation, and 3 percent for each of the

low and very low evaluations.

3.2.6 Consultant factor related

Based on the statistics that been collected from the survey, fig. (3.6) shows the most important factors affecting project duration, quality, and control management. Furthermore, according to expert opinions each paragraph will explain one of these factors.

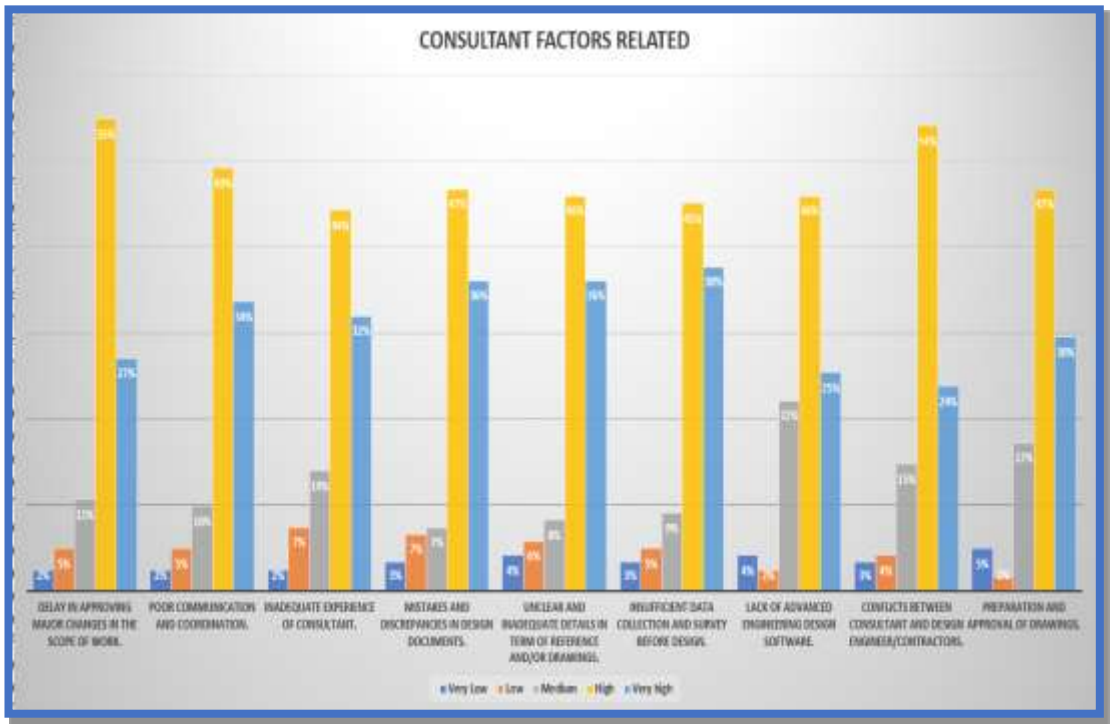


Figure 3.6: Shows Consultant Factor Related Factors

3.2.6.1 Approval delays of major changes in the scope of work

Referring to fig. (3.6), there is a high percent of participants sees that delay in approving changes by the consultant effect on project duration and the quality and control management this percentage represented by 55 percent. While 27 percent of participants sees that consultant, approving is very important factor and gave it a very high ranking. In return 18 percent consist of medium, low and very low ranking. Medium rank represents 11 percent, the low rank represent 5 percent and very low rank represents only 2%.

3.2.6.2 Poor communication and coordination

Based on fig. (3.6), it is shown that the highest percentage of participants gave a higher evaluation, and they are represented by 49 percent. While 34 percent gave a

very high rating to the effect of poor communication and coordination. In return 7% represent the sum of the low and very low rating, as it was distributed as 5 percent to the low and only 2 percent to the very low option. Moreover, only 10 percent gave it a medium rate.

3.2.6.3 Inadequate experience of consultant

Depending on fig. (3.6), the majority of the participants stated that the insufficient experience of the consultant has a high impact, as 44% indicated that. While 32 percent tend to very high effect, otherwise 14 percent of participants gave a medium rating to this factor. On the other side 7 percent believe that the consultants insufficient experience does not have a high effect so they gave a low rating to it. And only 2 percent with very low rating.

3.2.6.4 Mistakes and discrepancies in design document

According to fig. (3.6), the greatest percentage of the participants believe that mistakes and discrepancies in design document has a high impact where they represent 47percent. While 36 percent says that this factor is fairly important and gave it a very high rating, furthermore 7 percent of the respondent preferred to choose medium rating. In the other side 7 percent convinced that it has a low effect on project, and only 3 percent represent a very low impact.

3.2.6.5 Unclear and inadequate details in terms of reference and/ or drawing

Based on the statistics shown in fig. (3.6), 36% of the respondents clarify that unclear and inadequate details in term of reference and/or drawing is fairly important and gave it a very high rank. While the greatest percentage gave it a high effect represents 46 percent. Furthermore, 8 percent of the participants convinced that it has medium effect. Otherwise, 6 percent of the respondents stated that it has a low impact on project. And 4% tend to choose very low rank.

3.2.6.6 Insufficiency of collected survey data prior to design

Fig. (3.6) shows that the highest percent of respondents indicates that insufficiency of collection survey data prior to design has a high impact, which is represents 45 percent. While 38 percent represent very high rank. Also, about 9 percent of participants prefer to consider that this factor has a medium impact. Moreover, 5

percent of respondents do not believe that it has that huge effect, and they rate it low. Only 3 percent represents a very low rating.

3.2.6.7 Lack of advanced engineering design software

Based on fig. (3.6), the highest percentage of responds select a high effect rating where represents 46 percent. While the medium and very high ratings were close, the medium rating represented 22 percent, while the very high evaluation represented 25%. Moreover, 4 percent of the respondent don't believe that lack of advanced engineering design software has that effect on project duration and quality and control management, so this percent represent the very low rating. Finally, only 2 percent represent the low evaluation.

3.2.6.8 Disputes Among Consultant and Designer / Contractors

As shown in fig. (3.6), disputes among consultant and designer /contractors one of the most controversial factors about its impact on project duration, control and quality management. As the percentage of participants who chose the high evaluation was more than half and represented 54%. Also, 24 percent of the participants believed that it had a very high impact. Otherwise, 15 percent gave a medium rating for this factor. Moreover, 4 percent stated that it has a low effect and only 3 percent convinced that it has a very low rating.

3.2.6.9 Preparation and approval of drawings

Fig. (3.6) reveals that a fairly important percent of the participants say that preparation and approval of drawing has a high effect on project duration represented by 47 percent. Also, a significant proportion of the participants believe that it has a very high impact, as their percentage reached 30%. In return 17 percent of the respondent preferred the medium rating. Furthermore, 5 percent tend to choose a very low evaluation and only 2 percent considered a low evaluation for this factor.

3.2.7 Contractor and workers personnel

According to the survey, this part shows the effect of contractor and workers personnel and focus on the factors that are related to this section to what extent do these factors effect on quality management and project control. which consist of nine important factors will be discussed in the following depends on fig. (3.7),

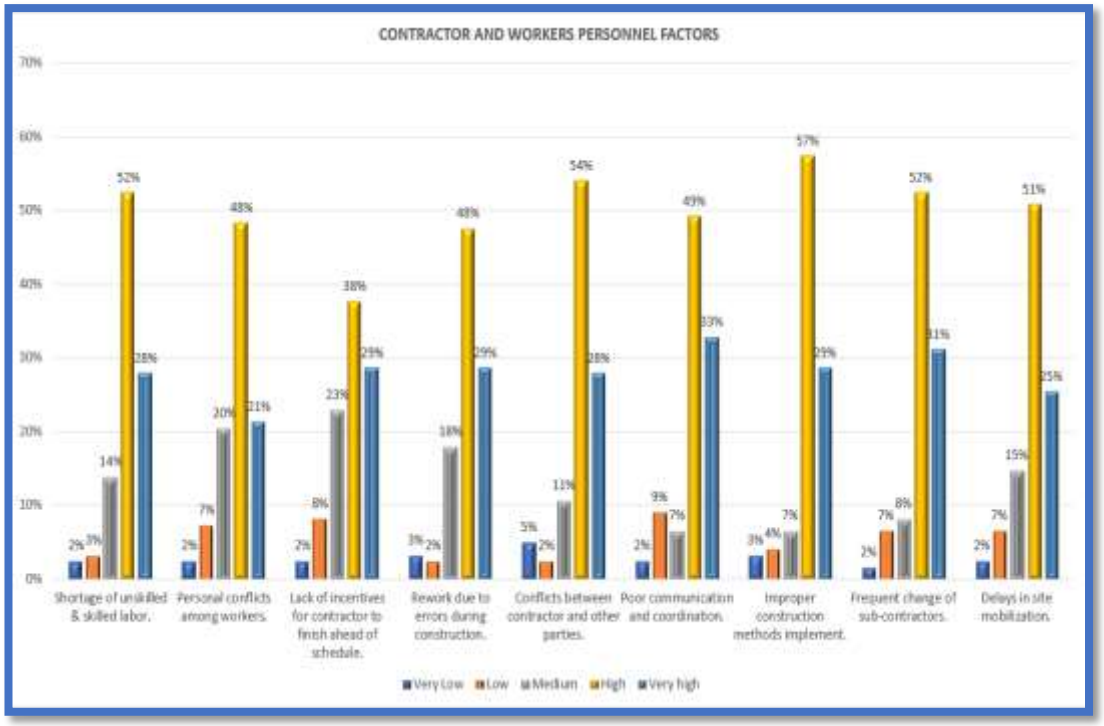


Figure 3.7: Shows contractor and workers personnel factors

3.2.7.1 Shortage of unskilled and skilled labor

Based on fig. (3.7), shortage of unskilled and skilled labor is a major factor affecting quality and control of any project. As the largest proportion of the participants believe that this factor has a significant impact, as their percentage reached 52 percent for high evaluation. While 28 percent of responds gave a very high rank for its effect. Otherwise, 14 percent represent the medium rating. And the lowest value was 2 percent for the very low evaluation and 3 percent for low rating.

3.2.7.2 Personal conflicts among workers

According to fig. (3.7), the highest proportion represents the high evaluation which is 48 percent. Also, a very high rank represents 21% of respondent. While 20 percent of the participants preferred to choose the medium rate for personal conflicts among workers. Otherwise, nine percent consist of low and very low rating, whereas low evaluation represent 7% and very low evaluation represent only 2 percent.

3.2.7.3 Shortage in incentives for contractors to complete a head of schedule

According to the data shown in fig. (3.7), 38 percent considered that lack of incentives for contractor has high effect on quality and control management. While 29 percent of respondents believe that is very important effect and gave it a very high

rank. In return 23% preferred to give a medium rating for it. Moreover, 8 percent of respondent don't believe on it which is represent the low evaluation and only two percent gave it a very low rating.

3.2.7.4 Reworks after construction errors

According to the statistics shown in fig. (3.7), reworks after construction errors are considerably major factors affecting quality and control management, and this effect also reflected in the duration of the project. As the respondents in the questionnaire believed that it had a high impact, as the percentage was close to half, as it was 48 percent. While 29 percent of respondents considered that it has a very high effect. Otherwise only 5 percent represents the low and very low effect, it was distributed as 3 percent for very low and 2 percent for low evaluation. Moreover, 18 percent of respondent stated that it has a medium effect.

3.2.7.5 Conflict between contractor and other parties

According to fig. (3.7), more than fifty percent of the participants considered that this factor had a high impact, as it was 54 percent for the high evaluation. While 28% of respondents preferred to choose the very high impact rating. Furthermore, eleven percent of respondent stated that it has a medium effect. In return 5 percent convinced it has a very low effect, and finally 2 percent tend to choose low evaluation.

3.2.7.6 Poor communication and coordination

Fig. (3.7), shows that largest proportion of respondents in the survey identified that poor communication and coordination has a high effect where it represents 49%. while 33 percent tend to choose a very high ranking for this factor. Moreover, 7 percent of respondents convinced that it has a medium effect. Also, 9 percent preferred to consider this factor as a low effect, however only 2 percent gave it a very low evaluation.

3.2.7.7 Improper construction methods implement

Based on statistics that shown in fig. (3.7), it is obvious that 57 percent of respondents believed that improper construction methods implement has a high effect on quality and control management. While 29% of respondents tend to choose

a very high rating for this factor. Furthermore, 7 percent of respondents gave a medium evaluation. However only 7 percent represents the low and very low effect which distributed as 3 percent for very low evaluation and only 4 percent for low rank.

3.2.7.8 Frequent change of sub-contractors

According to fig. (3.7), the largest proportion of the participants believe that the changing of contractors greatly effects on the quality management and project control, as their percentage represented by 52 percent. While 31 percent of participants preferred to choose a very high effect rating. In return 8 percent of respondent stated that it has a medium effect on quality and control management. Moreover 7% of the respondent don't believe that it has a high effect, so they prefer to choose a low evaluation. Whilst only 2 percent tend to choose a very low evaluation.

3.2.7.9 Delays in site mobilization

Based on statistics, 51% of respondents tend to choose a high effect on quality and control management. While 25 percent prefer to consider that mobilization has a very high evaluation. In return 15 percent found this option has a medium effect. Furthermore, 7 percent stated that it has a low rating. Moreover, only 2 percent of the respondent don't believe in that high effect and tend to choose a very low evaluation.

3.2.8 Equipment related

Equipment is a major factor affecting quality and control management with respect to project duration, as it has a large role that cannot be underestimated and not taken into consideration in the implementation of projects. Factors related to equipment include important parts. We will look at the most important ones in terms of impact, as shown in fig. (3.8).

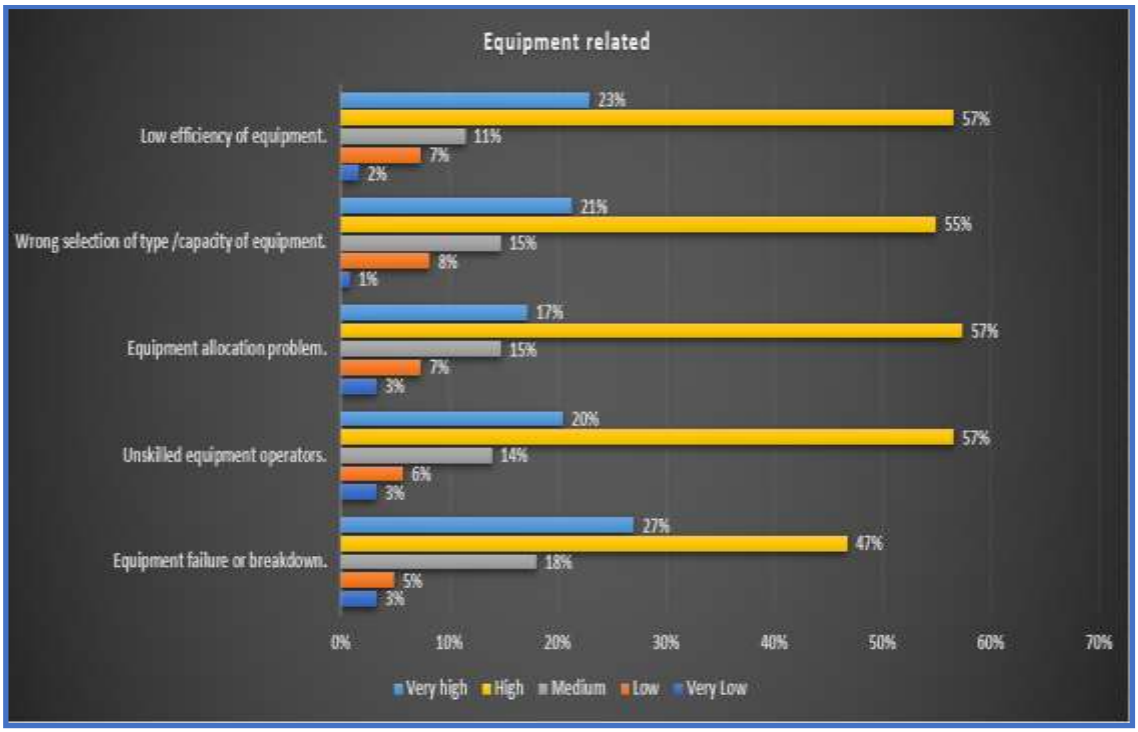


Figure 3.8: Shows Equipment Related Factors

3.2.8.1 Equipment failure or breakdown

Based on fig. (3.8), the highest percentage of respondents in the survey believed that equipment failure or breakdown has a high effect on quality and control management, as their ratio was represented by 47 percent. While 27 percent of respondents preferred to choose a very high evaluation. Furthermore, 18 percent of respondents found this option with a medium effect. In return 5 percent stated that this factor has a low rating. Moreover, 3 percent of the respondent do not believe that equipment failure or breakdown has a very low evaluation.

3.2.8.2 Unskilled equipment operators

According to fig. (3.8), unskilled equipment operators have a high effect on quality and control management, whereas 57 percent of respondents believe that it has a high rating. While 20 percent preferred to consider this factor has a very high evaluation. In return 14 percent of the respondents tend to choose a medium rank. Moreover, 9 percent of respondents convinced that unskilled equipment operators have a low and very low effect, it was distributed as 6 percent for the low evaluation and 3 percent for the very low evaluation.

3.2.8.3 Equipment allocation problem

Based on the given statistics on fig. (3.8), the highest proportion of participants tended to choose the high rating which is represented by 57 percent. While 17 percent of respondents found this option fairly important and gave it a very high rank. Otherwise, 15 percent of respondents preferred to consider this factor has a medium effect. In return 7 percent of responded stated that it has a low effect. Whilst only 3 percent convinced that equipment allocation problem has a very low effect on quality and control management.

3.2.8.4 Improper choice of type and capacity of equipment

According to fig. (3.8), the improper choice of type and capacity of equipment has a highly effects based on the percent of respondent that is represented by 55%. While 21 percent preferred to choose a very high rank. Otherwise, 15 percent of respondents believe that it has a medium effect. In return 8 percent convinced that the wrong selection of equipment has a low evaluation and only 1 percent tended to choose a very low evaluation.

3.2.8.5 Low efficiency of equipment

Based on statistics that shown in fig. (3.8), 57 percent of respondents believe that it has a high effect on quality and control management, while 23 percent preferred to consider that it has a very high effect. Otherwise, 11 percent tended to choose a medium evaluation. Moreover, 7 percent of the respondent do not believe that low efficiency of equipment has a high effect and gave it a low rating and only 2 percent represents the very low evaluation.

3.2.9 Material related

Materials factor considered as one of the most important factors that cannot be underestimated in their impact on project duration and management process. As there are many factors related to the material, according to fig. (3.9), shown below:

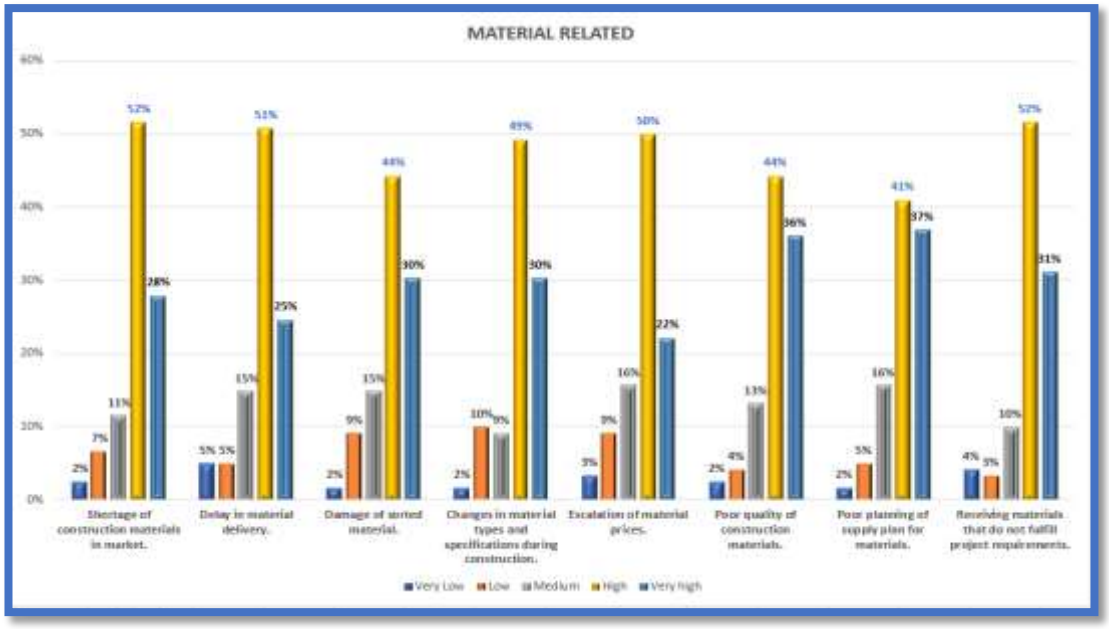


Figure 3.9: Shows material related factors

3.2.9.1 Shortage of construction materials in market

According to fig. (3.9), the highest proportion of respondents believed that shortage of construction materials in market has a high effect on quality and control management, which is represented by 52 percent. While 28 percent of respondent preferred to choose a very high rating for its effect. Moreover, 11 percent of respondent convinced that it has a medium effect. In return 7 percent says that it has a low effect, while 2 percent choose a very low evaluation.

3.2.9.2 Delay in materials delivery

Based on fig. (3.9), 5 percent of respondents found that delay in materials delivery has a very low effects on quality and control management, also 5 percent of respondents choose a low effects rank. While 15 percent preferred to choose a medium rating. In return the highest percent of respondents believe that delay in materials delivery has a high effect on quality and control management which is represented by 51 percent, furthermore 25 percent of respondents tend to choose a very high evaluation.

3.2.9.3 Damage of sorted materials

According to the statistics shown in fig. (3.9), 44 percent of respondents believe that damage of sorted material has a high effect on quality and control, while 30 percent

tended to choose a very high effect. In return 15 percent preferred to choose a medium rank for its effect. Furthermore, 11 percent of respondents consist of low and very low rating whereas 9 percent found it has a low effect and only 2 percent represent the very low evaluation.

3.2.9.4 Changing of type and specifications of materials throughout construction

Fig. (3.9) shows that the highest proportion of participants believed that Changing of Type and Specifications of Materials throughout Construction has a considerable effect on quality and control management and this percent represented by 49%. While 30 percent of respondents preferred to choose the very high evaluation. In return 9 percent gave this factor a medium rank. Furthermore, 10 percent of respondents stated that changes in material types has a low effect, and only 2 percent convinced that it has a very low effect.

3.2.9.5 Escalation of material prices

Only 3 percent of respondents found that escalation of material prices has a very low effects on quality and control management. While 9 percent tend to choose a low effect. Furthermore, 16 percent preferred to choose a medium rating. In return 50 percent of participants believed that escalation of material prices has a high effect on quality and control management, moreover 22 percent of respondents with the opinion of a very high evaluation.

3.2.9.6 Poor quality of construction materials

Based on fig. (3.9), the highest proportion of participants believe that weak construction materials quality has a highly affects quality and control management. Whereas 44 percent of respondents choose a high evaluation. While 36 percent of respondents tended to choose a very high rating. In return 13 percent of participants preferred to choose a medium effect. Furthermore, 4 percent of respondents don’t believe that it has a high effect and gave it a low rank. While only 2 percent convinced that it has a very low evaluation.

3.2.9.7 Poor planning of supply plan for materials

According to the statistics shown in fig. (3.9), it obvious that poor planning of supply plan for materials has a high effect on quality and control management with respect

to the duration of the project, whereas 41 percent of respondents believe that it has a high effect. While 37 percent of respondents preferred to choose a very high evaluation. In return 16 percent of participants tended to choose a medium rate. Moreover, 7 percent represent the low and very low evaluation whereas 5 percent for the low evaluation and only 2 percent for very low evaluation.

3.2.9.8 Receive of materials that mismatching with project demands

Surly, receive of materials that mismatching with project demands has a high effect on quality and control management based on respondents where it is more than half represented by 52 percent while 31 percent of respondents believe that it has a very high effect. In return only 10 percent of participants gave it a medium rank. Furthermore, 3 percent of respondents with the opinion said that it has a low evaluation, the rest were given a very low evaluation, as their percentage was represented by 4%.

3.2.10 Other factor related

This part discusses the various factors that has an impact on project duration and management process, which includes work accidents, underestimation of time of completion, geological problems on site, weak site management and inaccuracy of site testing, application of safety aspect, delays in extracting municipal permissions, provision of services, complexity of project, and legal disputes between project participants as shown in fig. (3.8);

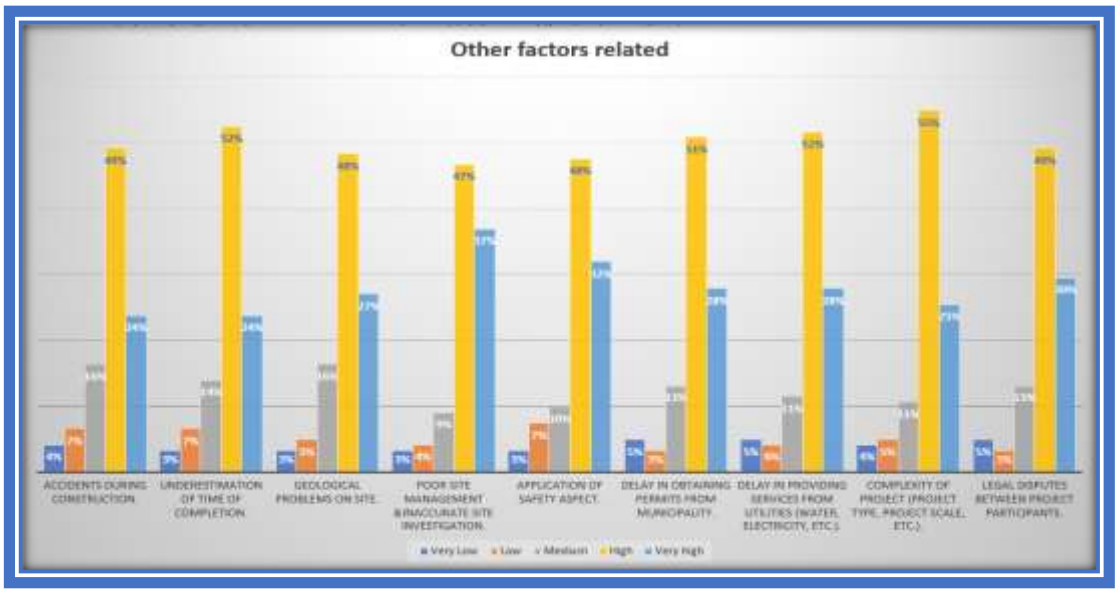


Figure 3.10: Shows Other Factor Related

3.2.10.1 Accidents during construction

According to fig. (3.8), the highest percentage of participants believe that accidents during construction has a high impact on project duration and management process which is represented by 49 percent. While 24 percent of respondents tend to choose the very high rank for its effect. Otherwise, 16 percent of participants preferred to choose a medium rating. Moreover, 7 percent with the opinion that says it has a low impact and only 4 percent convinced that it has a very low effect.

3.2.10.2 Underestimation of time of completion

Based on fig. (3.10), statistics shows that the highest proportion of participants believe that underestimation of time of completion has a high effect on quality and control management with respect to project duration and this percent represented by 52%. While 24 percent of respondent tended to choose a very high rating. In return 14 percent of respondents preferred to choose a medium evaluation. Otherwise, 7 percent of respondents convinced that this factor has a low effect on quality and control management, and only 3 percent gave a very low evaluation.

3.2.10.3 Geological problems on site

According to the data shown in fig. (3.8), geological problems on site affects highly on quality and control management, where 48 percent of participants tended to choose a high rating. While 27 percent gave it a very high rank. Furthermore, 16 percent of respondents with opinion that says it has a medium effect. Moreover, 5 percent stated that it has a low effect, and only 3 percent convinced that it has a very low evaluation.

3.2.10.4 Poor site management and inaccurate site investigation

Depending on fig. (3.8), the data shows that poor site management and inaccurate site investigation has a high effect on quality and control management whereas represented by 47 percent, and 37 percent of respondents tended to choose a very high evaluation for its effect. Furthermore, 9 percent of participants stated that it has a medium rank. Moreover, 7 percent represent the low and very low rating, the low evaluation represented by 4 percent and very low evaluation represented by only 3 percent.

3.2.10.5 Application of safety aspect

Based on fig. (3.8), 3 percent of respondents convinced that application of safety aspect has a very low effects on quality and control management, while 7 percent of participants gave a low evaluation. Furthermore, 10 percent of respondents preferred to choose a medium rating. In return 48 percent of respondents believe that it has a high effect, moreover 32 percent represents a very high evaluation.

3.2.10.6 Delay in obtaining permits from municipality

Fig. (3.8) shows that delay in obtaining permits has a high effect on control management specially in Iraq whereas represented by 51 percent. While 28 percent of participants stated that this factor has a very high effect. In return 13 percent of respondents preferred to choose a medium evaluation of this factor. Furthermore, 3 percent only tended to choose a low rank, moreover 5 percent of participants don't believe that delay in obtaining permits has those big effects and gave it a very low evaluation.

3.2.10.7 Delays in provision of infrastructure services (water, electricity, etc…)

Providing services at the work site is one of the most important factors because of its great role in the completion of the project, especially water and electricity based on the highest proportion of participants as shown in fig. (3.8), whereas represented by 52 percent. While 28 percent of respondents believe that delay in providing services has a very high effects on control management. In return 11 percent of respondents preferred to choose a medium rank for this factor. Moreover, 4 percent convinced that it has a low effect, and only 5 percent of respondents gave a very low evaluation.

3.2.10.8 Project complexities (project type, scale, etc.)

Fig. (3.8) reveals that 55 percent of respondents considered that complexity of project has a high effect on quality and control management. While 25 percent of respondents with the opinion says that it has a very high effect. In return 11 percent of participants preferred to choose a medium rating. Moreover, 5 percent convinced that this factor has a low effect on quality and control management. 4 percent only tended to choose a very low evaluation.

3.2.10.9 Legal disputes between project participants

As obvious from fig. (3.8), 49 percent of respondents believe that legal disputes have a high effect on control management, while 30 percent of respondents tended to choose a very high evaluation. In return 13 percent of respondents stated that this factor has a medium effect on control management. Furthermore, 3 percent with the opinion that says it has a low effect and only 5 percent gave a very low evaluation for legal disputes factor.

3.2.11 Respondents ranking for the proactive steps that avoid or reduce water project duration factors

Fig. (3.9) Below lists the proactive steps analyses for avoiding or reducing water projects delay.

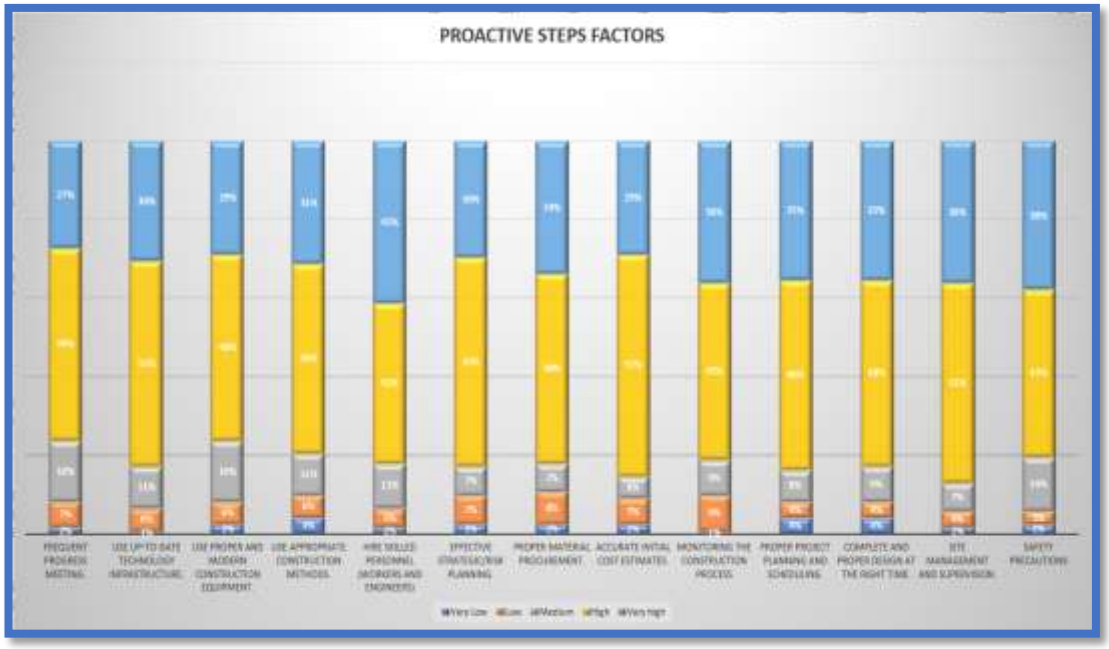


Figure 3.11: Shows Respondents Ranking For the Proactive Steps That Avoid or Reduce Water Project Duration Factors

3.2.11.1 Frequent progress meeting

According to fig. (3.11), 49 percent of respondents believe that this step is important and gave it a high rank, while 27 percent of respondents tended to choose a very high evaluation. Furthermore, 16 percent of respondents preferred to choose a medium rank. Moreover, 7 percent found that this step is not important and give it a low rating, and only 2 percent convinced that this step isn't very important and give it a very low evaluation.

3.2.11.2 Use up-to-date technology infrastructure

Based on fig. (3.11), the highest proportion of participants believe that use up to date technology infrastructure has a high effect on quality and control management even on project duration, whereas this respondent represented by 52 percent. While 30 percent of participants preferred to choose a very high evaluation. In return 11 percent of respondents tended to choose a medium rating for this factor. Furthermore, about 6 percent stated that this factor has a low effects, and only 1 percent gave a very low evaluation.

3.2.11.3 Use proper and modern construction equipment

Depending on fig. (3.11), 29 percent of respondents considered that use proper and modern construction equipment is a fairly important step and gave it a very high rank. While 48 percent of participants believe that this factor has a high effect on quality and control management. Furthermore, 16 percent of respondents tend to choose a medium rating for this factor. Moreover, 6 percent of respondent stated that use proper equipment has a low evaluation. Whilst only 2 percent convinced that this step has a very low evaluation.

3.2.11.4 Use appropriate construction methods

Based on statistics shown in fig. (3.11), 48 percent of participants with the opinion that says use appropriate construction methods has a high effect on quality and control management. While 31 percent of respondents believe that this factor has a very high effect. In return 6 percent of respondents convinced that use appropriate construction methods has a low effect on quality and control management. Moreover, 4 percent of respondents considered that it has a very low evaluation. Whilst 11 percent of respondents preferred to choose a medium evaluation.

3.2.11.5 Hire skilled personnel (Workers and engineers)

Based on data shown in fig. (3.11), the highest proportion of participants believe that hire skilled personnel has a fairly important impact on delay of water projects even on quality and control management, whereas 82 percent of respondents represents the high evaluation and very high evaluation where 41 percent for each one of them. Moreover, 11 percent of respondents preferred to choose a medium evaluation. In

return 5 percent convinced that skilled personnel have a low effect on water projects delay, and only 2 percent gave it a very low evaluation.

3.2.11.6 Effective strategic / risk planning

As shown in fig. (3.11), effective strategic/ risk planning considered as one of the most important factors that can reduce or minimize water project delay according to the respondent's percent where 53 percent of respondents represent the high evaluation, while 30 percent of respondents believe that this factor has a very high impact. Moreover, 7 percent of respondents stated that effective strategic / risk planning has a low impact on reduce water project delay and only 2 percent gave it a very low evaluation. Whilst 7 percent of respondents preferred to choose a medium evaluation.

3.2.11.7 Proper material procurement

According to fig. (3.11), the highest proportion of participants believe that proper material procurement highly affects minimizing delays in water projects and this percent represented by 48%. While 34 percent also agree it's important and gave a very high evaluation. Furthermore, 7 percent of respondents preferred that this factor has a medium effect. In return 8 percent convinced that it has a low effect, and only 2 percent of respondents stated that it has a very low effects on these kinds of projects.

3.2.11.8 Accurate initial cost estimates

Based on data shown in fig. (3.11), surely accurate initial cost estimates one of the most important factors that should be taken in consideration because of their biggest effects on delay in water projects, where the highest percent of respondents believe that it has a high effect and this percentage represented by 57%. While 29 percent of participants gave it a very high rank for its effect, in return 6 percent of respondents preferred to choose a medium evaluation for it. Furthermore, 7 percent of respondents convinced that it has a low effect, as well as only 2 percent gave a very low evaluation.

3.2.11.9 Monitoring the construction process

In this aspect, we note the interrelationship between quality management and control and its relationship to reducing the delay or lack of control over duration of the

project. So according to the statistics shown in fig. (3.11), the highest proportion of participants believe that monitoring the construction process has a high effect on reducing the delay of water projects and this percent represented by 45%. Also, 36 percent of respondents admitted that it effects highly on minimizing projects delay. Furthermore, 9 percent of respondents gave a medium rating. In return 9 percent of respondents preferred to choose a low evaluation while only one percent convinced that it has a very low effects on water project delay.

3.2.11.10 Proper project planning and scheduling

Depending on the statistics of fig. (3.11), it is clear that proper project planning and scheduling has a high effect on decreasing water projects delay and this percent represented by 48%. While 35 percent of respondents believe that it has a very high evaluation. Furthermore, 8 percent of respondents considered that this step has a medium evaluation. Moreover, only 4 percent of respondents convinced that proper project planning and scheduling has a low and very low effects on water projects delay for each one of them.

3.3 Survey Result

The results obtained from the questionnaire- based survey identifies 40 key -factors of project duration in construction of water projects, that have a high and very high effect, and the maximum value of (α) for those key factors value of (0.9721), whereas the minimum value is (0.9275) as calculated by equation (3). The ANOVA analyses are reported in table (3.2), i.e. (The values of the count of respondents, sum, mean (M), and Standard Deviation (S.D) in addition the Alpha Cronbach's coefficient (α) for the key impact factors that affect the duration of water projects.

Table 3.2: The Highest Ranked Delay Factors In Construction of Water Projects in Iraq. the Factors Have Been Sorted From Highest to Lowest According to the Highest Value of Percentage and Low Value of Variance (S.D).

1- Consultant- related factors				**Cronbach's Alpha**		**0.9454**
Groups	*Count*	*Sum*	*Average*	*Variance*	*Effect Level*	*%*
Insufficiently collected survey data prior to design.	122	499	4.090163934	0.958745427	High	82%
Weak communication and coordination.	122	496	4.06557377	0.855168676	High	81%
Errors and contradictions in design documentation.	122	495	4.057377049	0.996680667	High	81%

Table 3.2: (Cont.) The Highest Ranked Delay Factors In Construction of Water Projects in Iraq. The Factors Have Been Sorted From Highest To Lowest According To the Highest Value of Percentage and Low Value of Variance (S.D).

Unclearness and inadequacy of details in terms of reference and/or drawings.	122	493	4.040983607	1.047893239	High	81%
Delayed approval of major variations in the scope of the work.	122	487	3.991803279	0.801585151	High	80%
Inadequacy of consultant experience.	122	483	3.959016393	0.981777537	High	79%
Preparation and approval of drawings.	122	481	3.942622951	0.980151741	High	79%
Arguments among consultant and designer/contractors.	122	477	3.909836066	0.843042948	High	78%
Lack of advanced engineering design software.	122	471	3.860655738	0.93083593	High	77%
Groups	*Count*	*Sum*	*Average*	*Variance*	*Effect Level*	*%*
Repeated variation of sub-contractors.	122	494	4.049180328	0.807478661	High	81%
Implementation of improper construction techniques.	122	493	4.040983607	0.816488281	High	81%
Weak communication and coordination.	122	489	4.008196721	0.983403333	High	80%
Shortage of unskilled & skilled labor.	122	488	4	0.776859504	High	80%
Arguments between contractor and other parties.	122	485	3.975409836	0.933274624	High	80%
Reworks due to mistakes throughout construction.	122	483	3.959016393	0.866075058	High	79%
Delays of site mobilization.	122	476	3.901639344	0.882807208	High	78%
Shortage in incentives for contractor for completing ahead of schedule.	122	466	3.819672131	1.04159328	High	76%
Personal conflicts among workers.	122	462	3.786885246	0.896355507	High	76%
3- Equipment-related factors				**Cronbach's Alpha**		**0.9275**
Groups	*Count*	*Sum*	*Average*	*Variance*	*Effect Level*	*%*
Low efficiency of equipment.	122	478	3.918032787	0.78661428	High	78%
Breakdown or failure of equipment.	122	475	3.893442623	0.93896491	High	78%
Incorrect type or capacity selection of equipment.	122	473	3.87704918	0.753353204	High	78%
Unskilled equipment operators.	122	470	3.852459016	0.854084812	High	77%
Problems of equipment allocation.	122	461	3.778688525	0.86797182	High	76%
4- Material-related factors				**Cronbach's Alpha**		**0.9584**
Groups	*Count*	*Sum*	*Average*	*Variance*	*Effect Level*	*%*
Weak quality of construction materials.	122	497	4.073770492	0.878810459	High	81%
Weak planning of supply plan for materials.	122	496	4.06557377	0.871697602	High	81%

Table 3.2: (Cont.) The Highest Ranked Delay Factors In Construction of Water Projects in Iraq. The Factors Have Been Sorted From Highest To Lowest According To the Highest Value of Percentage and Low Value of Variance (S.D).

Receive of materials that mismatch with project demands.	122	491	4.024590164	0.916745698	High	80%
Variations in types and specifications of materials throughout construction.	122	484	3.967213115	0.941064896	High	79%
Lack of construction materials in market.	122	483	3.959016393	0.882603983	High	79%
Damage of sorted material.	122	479	3.926229508	0.961455087	High	79%
Delays of materials delivery.	122	470	3.852459016	1.019374069	High	77%
Escalated material prices.	122	462	3.786885246	0.995529061	High	76%
5- Other factors related				**Cronbach's Alpha**		**0.9721**
Groups	*Count*	*Sum*	*Average*	*Variance*	*Effect Level*	*%*
Poor site management &Inaccurate site investigation.	122	500	4.098360656	0.915865059	High	82%
Application of safety aspect.	122	485	3.975409836	1.015919252	High	80%
Legal disputes between project participants.	122	482	3.950819672	1.005825769	High	79%
Delayed extraction of municipal permissions	122	480	3.93442623	0.987400081	High	79%
Provision delays of utility services (water, electricity, etc.).	122	480	3.93442623	1.003929007	High	79%
Project Complexity (project type and scale, etc.).	122	479	3.926229508	0.928397236	High	79%
Geological problems on site.	122	477	3.909836066	0.925687576	High	78%
Underestimation of time of completion.	122	472	3.868852459	0.924806937	High	77%
Accidents during construction.	122	466	3.819672131	1.008535429	High	76%

Table (3.3) lists the rank earned by the 40 cause factors without classifying them in any category. It is found that top 10 factors causing influence of project duration are: (1) Weak site management together with inaccurate site testing, (2) Inadequately collected survey data prior to design, (3) Weak quality of construction materials, (4) Poor communication and coordination, (5) Poor planning of supply plan for materials, (6) Errors and contradictions in design documentation, (7) Frequent change of sub-contractors, (8) Unclear and inadequate details in term of reference and/or drawings.(9) Improper construction methods implement and (10)Received materials that mismatch with project demands.

Table 3.3: Ranking of All Causes Factors According to the Highest Value of Percentage and Low Value of Variance (S.D).

Factors	Average	Variance	Effect Level	%	Main Group
Weak site management together with inaccurate site testing.	4.098	0.916	High	82%	Other factors related
Inadequately collected survey data prior to design.	4.090	0.959	High	82%	Consultant Factors
Poor quality of construction materials.	4.074	0.879	High	81%	Material related
Poor communication and coordination.	4.066	0.855	High	81%	Consultant Factors
Poor planning of supply plan for materials.	4.066	0.872	High	81%	Material related
Mistakes and discrepancies in design documents.	4.057	0.997	High	81%	Consultant Factors
Frequent change of sub-contractors.	4.049	0.807	High	81%	Contractor and workers/personnel related
Unclear and inadequate details in term of reference and/or drawings.	4.041	1.048	High	81%	Consultant Factors
Improper construction methods implement.	4.041	0.816	High	81%	Contractor and workers/personnel related
Received materials that mismatch with project demands.	4.025	0.917	High	80%	Material related
Poor communication and coordination.	4.008	0.983	High	80%	Contractor and workers/personnel related
Shortage of unskilled & skilled labor.	4.000	0.777	High	80%	Contractor and workers/personnel related
Approval delays of major variations of the scope of work.	3.992	0.802	High	80%	Consultant Factors
Arguments among contractor and other parties.	3.975	0.933	High	80%	Contractor and workers/personnel related
Application of safety aspect.	3.975	1.016	High	80%	Other factors related
Variations of materials types and specifications throughout construction.	3.967	0.941	High	79%	Material related
Inadequate experience of consultant.	3.959	0.982	High	79%	Consultant Factors
Rework due to errors during construction.	3.959	0.866	High	79%	Contractor and workers/ personnel related
Shortage of construction materials in market.	3.959	0.883	High	79%	Material related
Legal disputes between project participants.	3.951	1.006	High	79%	Other factors related
Preparation and approval of drawings.	3.943	0.980	High	79%	Consultant Factors
Delays in extracting municipal permissions.	3.934	0.987	High	79%	Other factors related

Table 3.3: (Cont.) Ranking of All Causes Factors According to the Highest Value of Percentage and Low Value of Variance (S.D).

Factors	Average	Variance	Effect Level	%	Main Group
Delays in provision of utility services (water, electricity, etc.).	3.934	1.004	High	79%	Other factors related
Damage of sorted material.	3.926	0.961	High	79%	Material related
Project complexities (project type and scale, etc.).	3.926	0.928	High	79%	Other factors related
Low efficiency of equipment.	3.918	0.787	High	78%	Equipment related
Conflicts between consultant and design engineer/contractors.	3.910	0.843	High	78%	Consultant Factors
Geological problems on site.	3.910	0.926	High	78%	Other factors related
Delays in site mobilization.	3.902	0.883	High	78%	Contractor and workers/personnel related
Equipment failure or breakdown.	3.893	0.939	High	78%	Equipment related
Incorrect selection of equipment type and capacity.	3.877	0.753	High	78%	Equipment related
Underestimated time of completion.	3.869	0.925	High	77%	Other factors related
Lack of advanced engineering design software.	3.861	0.931	High	77%	Consultant Factors
Unskilled equipment operators.	3.852	0.854	High	77%	Equipment related
Delay in material delivery.	3.852	1.019	High	77%	Material related
Shortage in incentives for contractors to complete ahead of schedule.	3.820	1.042	High	76%	Contractor and workers/personnel related
Accidents during construction.	3.820	1.009	High	76%	Other factors related
Personal conflicts among workers.	3.787	0.896	High	76%	Contractor and workers/personnel related
Escalation of material prices.	3.787	0.996	High	76%	Material related
Equipment allocation problem.	3.779	0.868	High	76%	Equipment related

3.4 Pareto Chart

PARETO chart has been used as a graphical tool to help identifying the weight of each origin group of delay factors according to the mean values, as listed table (3.2), and illustrated in fig. (3.12). It is a bar chart depicting in descending order the frequency of the different effect factors categories.

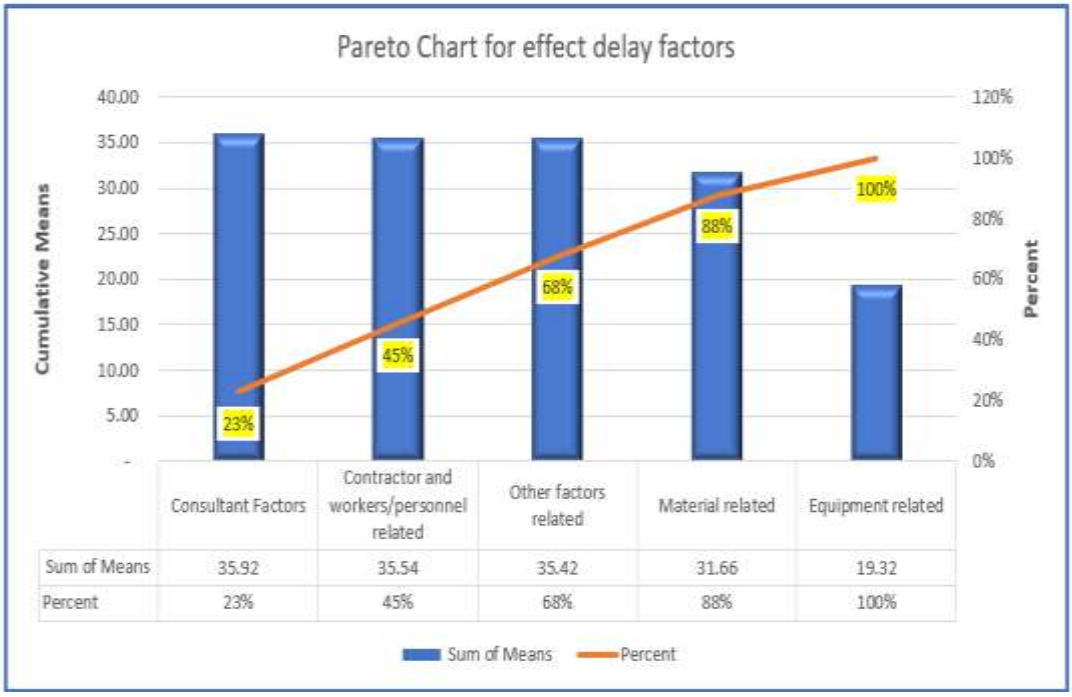


Figure 3.12: Shows Pareto Chart for Effect Delay Factors

4. CONCLUSIONS, STUDY LIMITATIONS AND RECOMMENDATIONS

4.1 Conclusions

The impact of project duration in rehabilitation /construction of water projects is always considered as a potential obstacle to project success. The present investigation establishes that a number of causative factors exists, that need to be thoroughly dealt with when schedule overruns, cost escalates and quality shortfalls are to be minimized on construction of water projects in Iraq. Despite being a subject of discussion for over decades, schedule overruns, cost escalation and quality shortfalls still persist as a challenge on water projects. All effective factors that impact on project duration and management process were identified.

Weak site management and Inaccurate site testing, insufficiency of survey data collected prior to design, poor quality of construction materials, poor communication and coordination, poor planning of supply plan for materials, errors and contradictions in the design documentation, and frequent change of sub-contractors are the most significantly affecting causal factors on schedule overruns, whereas those concerning quality shortfalls includes; unclear and inadequate details in term of reference and/or drawings. Improper construction methods implement and received materials that mismatches with project demands.

4.2 Limitations

The presently reported study should consider some limitations, focus of the study is paid to the construction of water projects from a comprehensive point of view. The results may vary with diffrent project types. However, the basic principles followed in the present investigation are certainly applicable to all other types of construction projects. The results have been reflected the status of present projects in public sector. Projects implemented by the private sector may suffer additional or different challenges from those presented in the current study.

4.3 Recommendations Related to the Results of the Study

From the results we can explore the most important causes mainly came from the other factors related and consultant factors, contractor, workers/personnel related, materials and equipment groups; the following recommendation are presented to reduce and control the impact of duration in construction of water projects:

1. Errors and contradictions in the design/drawing documentation have to be reduced to zero, to avoid the impact of consuming extra time for making the required corrections or revisions.
2. Data that have been collected from water project site and accurate quesionaires information lead to best baseline for designing water projects facilities from (documents, drawings, Maps,...etc) accurately so that will reduce time consumption for redesign some details that be incorrect or need to revised.
3. Assigning professional project manager and good technical staff as soon as project has been awarded good practice to achieve the project within specified duration and with the required quality and estimated cost.
4. Involving the private sector and the public sector in formulating a strategic plan that aspires to implement quality in construction of water projects through true partnership between all.
5. There is a need to ensure that project managers, technical staff, labour. personnel or consultants managing construction projects have sufficient training in construction project management and have the ability to learn new technologies.
6. Usage of tested and good quality of materials having good knowledge about construction materials, proper mix proportions, good site supervision, this will prevent poor quality in construction.
7. Realizing that communication is the most important element and keep managers, supervisors, staff and stakeholders informed and on track to closely followup the project activities because poor communication causes most project management failures.

8. One of the most important criteria is the selection process of the contractors and sub-contractors should not be based on the lowest bid, but should be selected according to experience and capabilities in terms of labours, equipments, financial and also have agood reputation.
9. Conduction frequent meeting with sector partners and/or stakeholders.
10. Using new software packages for planning and monitoring duration of project.

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RESUME

Omer Sabbar ALHURAISHI

PERSONAL STATEMENT:

My study is master degree in engineering management by Gedik University. My awarded educational degree was the B.Sc. degree in civil engineering by Al-Rafidain University College in 2019, I developed extensive skills needed for many kind of works' type that deal with computer and related software. I'm excellent to accommodate myself with most difficult situations and finding a way to make my works' outputs as requested. My skills and experience will be an asset.

SKILLS:

Based on the fact that every job requires a basic understanding of computers, and many jobs involve intermediate to advanced computer skills. I tried in the last years to develop my personal knowledge of specific software, applications or devices. In addition to my personal basic knowledge of the essential programs, like Microsoft Word,Excel and Power point. I increased my computer skills to include:

1. Social Media
2. Graphic Design
3. Microsoft Office
4. Spreadsheets
5. Email Communication
6. Data Visualization.

Foundational Competencies: Commitment, Integrity, Self-Awareness & Self-Regulation, Teamwork and ability to manage many activities in one time.

Functional Competencies: Initiative; Analytical ability; Planning and monitoring skills; Ability to organize work and projects; Commitment to have continuous learning for professional development.

EDUCATION:

İstanbul Gedik University

M.Sc Degree in Engineering management, Feb 2020 to Jul 2022

Thesis topic "the impact factors of construction project duration and management process"

Supervisor: Assist. Prof. Dr. Gokhan KAZAR

This study explores the the impact factors of construction project duration and management process

Civil Engineering/ Al-Rafidain University College, BAGHDAD

B.Sc. Degree in Civil Engineering , Oct 2015 to Jul 2019

Al-Adhamiyah High School for Boys BAGHDAD, Iraq High School certification, Oct 2008 to Jul2015

WORK EXPERIENCE IN REVERSE ORDER:

Ihsan Al-Sudani company for Electrical, Iraq , 1 Aug 2017 to 30 Sep 2017

1. Assist in design of electrical kiosks by Autocad software.
2. Working on web for procurment offshore electrical materials.
3. Translate and Prepare company invoices by computer in both Arabic and English.
4. Monitoring and Checklist of spare parts in stock by Excel sheet.
5. Organize and maintain contact details of partners using standard formats.
6. Collect and maintain an inventory of relevant documents on the company, i.e. stock reports, invoices, etc, made accessible in an appropriate location – hard copies, email, web, etc.

Ihsan Al-Sudani company for Electrical, Iraq ,1 Aug 2016 to 30 Sep 2016

1. Translate company supported documents .
2. Prepare company invoices by computer in both Arabic and English.
3. Monitoring and Checklist of spare parts in stock by Excel sheet.
4. Organize and maintain contact details of partners using standard formats.

SPECIALIZED TRAINING:

- IELTS. 29 Oct 2015 to 29 Dec 2015

Al-Khalid international group for training and development

Purpose (The International English Language Testing System (IELTS) is one of the two most widely accepted tests of English language proficiency at the tertiary level (the other is the Test of English as a Foreign Language, or TOEFL), The purpose of the IELTS is to give us the ability of handling English language regarding study or work in a country where English is the language of communication).

- Excel for Data entry and Data Analysts 14 Aug 2016 to 25 Aug 2016

Face to face training, It is a very comprehensive course that the trainig has been covered the following content topics:-

1) Data entry and Data analysis on real life data sets

2) Data cleaning and manipulation

3) Data visualization