



REPUBLIC OF TÜRKİYE

ALTINBAŞ UNIVERSITY

Institute of Graduate Studies

Civil Engineering

**LOSSES RESULTING FROM EXCEEDING THE
SPECIFIED TIME FOR COMPLETION AND ITS
IMPACT ON THE STATUS OF THE PROJECT
AND DELAY IN UTILIZING SERVICES**

Abdulrahman Ali Kareem AL-MAFRACHI

Master`s Thesis

Supervisor

Assoc Prof. Dr. Sepanta NAİMİ

Istanbul, 2023

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Signature

DEDICATION

My gorgeous father and beloved mother have consistently given me love, support, assistance, and enthusiasm while I have pursued my studies, and I want to dedicate this work to them. We gratefully acknowledge the professors and medical personnel at Altınbaş University, my supervisor, and the entire civil engineering staff for their support, direction, and significant experience in this work. My supervisor also provided me with a ton of guidance and support for my numerical and statistical analysis.

I also want to thank everyone at Altınbaş University for giving me their time and help so I could do my research and finish my thesis analysis.

ACKNOWLEDGMENT

I want to start by giving God Allah praise for endowing me with the skills, endurance, and tenacity needed to finish this master's thesis. I also want to thank the professors, the department of civil engineering, and the project management doctors for helping me write my results and finish my assignment. I also want to express my profound gratitude to Assoc. Prof. Dr. Sepanta NAİMİ, my associate professor, for his patience, cooperation, and support. Without his invaluable advice and motivation, I could not have completed my REVIT and cross-sectional analysis. I also hope the results of my research will suit my supervisor.

I also want to express my gratitude to the test committee members who helped me out by giving me sound advice and criticism. I also want to thank the staff and faculty at Altınbaş University for their never-ending support.

ABSTRACT

LOSSES RESULTING FROM EXCEEDING THE SPECIFIED TIME FOR COMPLETION AND ITS IMPACT ON THE STATUS OF THE PROJECT AND DELAY IN UTILIZING SERVICES

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Date: April / 2023

Pages: 184

This research is conducted to estimate the critical contributions and roles of BIM technology in managing the cost and schedule evaluation of a construction project. The study depends on a cross-sectional study (using online survey questionnaires) and numerical analysis (using REVIT quantity take-off) to achieve the study targets. These approaches are vital to address critical factors affecting losses resulting from exceeding the specified time for completion and its impact on the status of the project and delay in utilizing services by designing a questionnaire and distributing it using a Google model to a group of specialists in engineering projects and evaluating the most prominent factors in terms of the degree of importance and their impact on the construction and contracting sector. The results indicated that using the numerical REVIT quantity take-off to calculate the cost, schedule, and amount of construction materials provided significant levels of time, effort, and cost reduction for engineers. In addition, it was remarkably accurate compared with manual calculations. In addition, it was found that the executing companies are a significant reason for the delay in the implementation of projects. Moreover, the study confirmed that there are risks that affect the delay in the implementation of projects, and these risks include construction

mismanagement, poor communication, financial, legal, market, policy and politics, and technical risks.

Keywords: Construction Projects, Project Management, Iraqi Engineers, REVIT Quantity Take-Off, Schedule, Cost, BIM Technology.



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ABBREVIATIONS

ANP	:	Analytical Network Process
BIM	:	Building Information Modeling
CPI	:	Cost Performance Index
DBB	:	Design of Bid Building
DB	:	Building Design
D–S	:	Dempster–Shafer
MOMRA	:	Ministry of Rural and Municipal Affairs
MOH	:	The Ministry of Health
MOE	:	The Ministry of Education
MitC	:	Mitigation Controller
M-PERT	:	The Manual Program Evaluation Review and Technique
R&D	:	Research and Development
SPI	:	Schedule Performance Index
SPSS	:	The Social Sciences in the Statistical Package

LIST OF SYMBOLS

S	:	The standard deviation
f_i	:	The frequency
x_i	:	The degree of the criterion importance
C	:	The average inter-item variance between items
SSL	:	Statistical significance level
<i>Standard Error</i>	:	The error which is being tested.
V	:	The average variance of all items
X	:	The mean score
Z	:	The standard score corresponding to the significance level.
N_{it}	:	The number of items
<i>Observed Value</i>	:	The statistic (sample mean), which is computed from the sample data
d	:	The standard error related to the sampling distribution.
n	:	The size of the sample
<i>Expected Value</i>	:	The parameter (population mean) which would expect to obtain if the null hypothesis were (hypothesized value)
Ms	:	The mean score ($1 \leq Ms \leq 5$)
N	:	The size of the population
Nr	:	The Total number of responses for that factor or option
p	:	The proportion of the population
μ	:	The hypothesized population mean

1. INTRODUCTION

1.1 RESEARCH BACKGROUND

Every country's construction business is a vibrant one and is responsible for beneficial impacts and important contributions to the country's economy. These benefits include the expansion in the nation's income, growing the local GDP, bringing experience for senior and junior engineers, the provision of high wages, the freedom to travel, and offering of various types of careers in the same construction project. Thus, it is vital to ensure that the construction sector in each territory is functioning properly without facing any problems, as the degradation or weakness of this sector would contribute to dramatic economic disadvantages and negative impacts on the country, mirrored by lower GDP, fair financial liquidity, and a lower rate of job opportunities for different individuals, including engineers and the labor force [1]–[10]. Consequently, project management principles are adopted and implemented in various construction and contracting companies besides the engineering consulting firms helping achieve many contributions and important benefits [11]. For instance, implementing project management standards and rules can help resolve common problems in construction that could cause lower client satisfaction, such as delays in project submission, slower adoption of technology and digitalization, insufficient communication, cash flow problems, and the lack of skilled engineers and workers [9], [10]. Furthermore, project management adoption and employment in the construction industry are vital to helping top management and project managers complete their construction projects on time and avoid any losses in the budget due to retardation in the achievement [8], [10]. Moreover, project management is useful to support construction decision-makers in deciding significant judgements to save time and money for the project. Project management can also help the construction business run smoothly by alleviating and minimizing different types of risks on the construction site and during the construction phases [7]–[9], [12]–[19].

1.2 PROBLEM STATEMENT

Several project managers face a critical and common problem in construction projects mirrored by delay. The delay issue in various construction projects can contribute to different negative consequences and unfavourable impacts on the construction project. These

undesirable effects include the requirement for more expenditure, unsatisfying customers' and owners' demands, project infeasibility, total abandonment, litigation, arbitration, cost overrun, and other stakeholders' disagreement [20], [21]. Additionally, owners and clients may file a lawsuit against the project manager due to the delay problem that could cause some issues to their business [11], [22]–[25]. For this reason, it is greatly considerable to consult project management professionals and construction experts regarding critical solutions and beneficial approaches they adopted when they had this problem before. Their points of view are remarkably significant and relevant to help top managers, project managers, senior engineers, planners, and other project stakeholders submit their construction projects on time, avoiding any delay problem that could cause substantial negative impacts on clients' satisfaction and harmful influences on the project and customers' business. Consequently, this research is carried out to address the delay problem of construction projects and consult various project management experts and construction professionals to provide their essential opinion and advice that could help mitigate this problem and resolve the retardation issue of construction projects to achieve better clients' satisfaction and avoid any financial losses. In addition, it tries to identify the critical role of modern project management solutions, including Building Information Modelling (BIM) Technology to solve this issue, which is broadly investigated by several researchers, who found that BIM plays a critical role in minimizing delay of construction projects [10], [26]–[65]. Figure 1.1 indicates major BIM technology principles for construction projects.

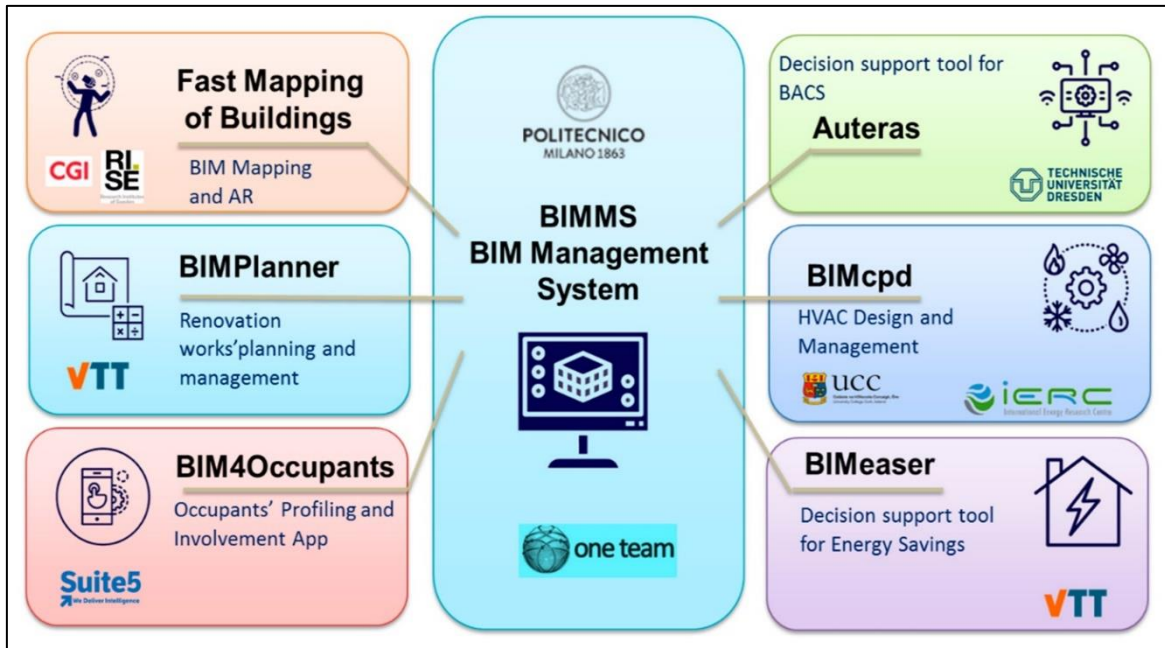


Figure 1.1: Major BIM Technology Principles for Construction Projects [66].

In addition, Figure 1.2 represent a configuration of critical frameworks and systems used in the BIM technology used in construction.

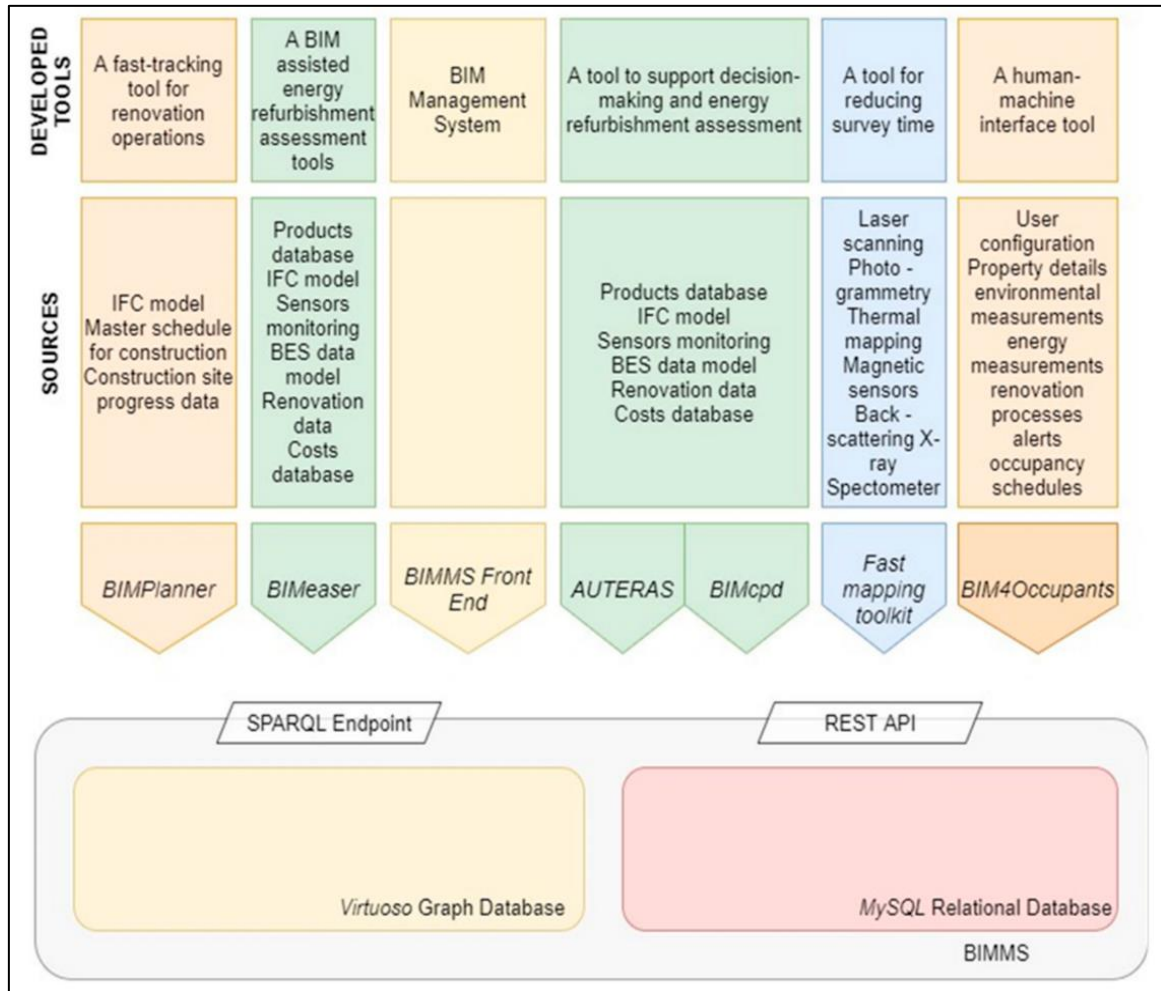


Figure 1.2: Configuration of Critical Frameworks and Systems Used in The BIM Technology Used in Construction [66].

Figure 1.3 illustrates major resources used in the BIM techniques.

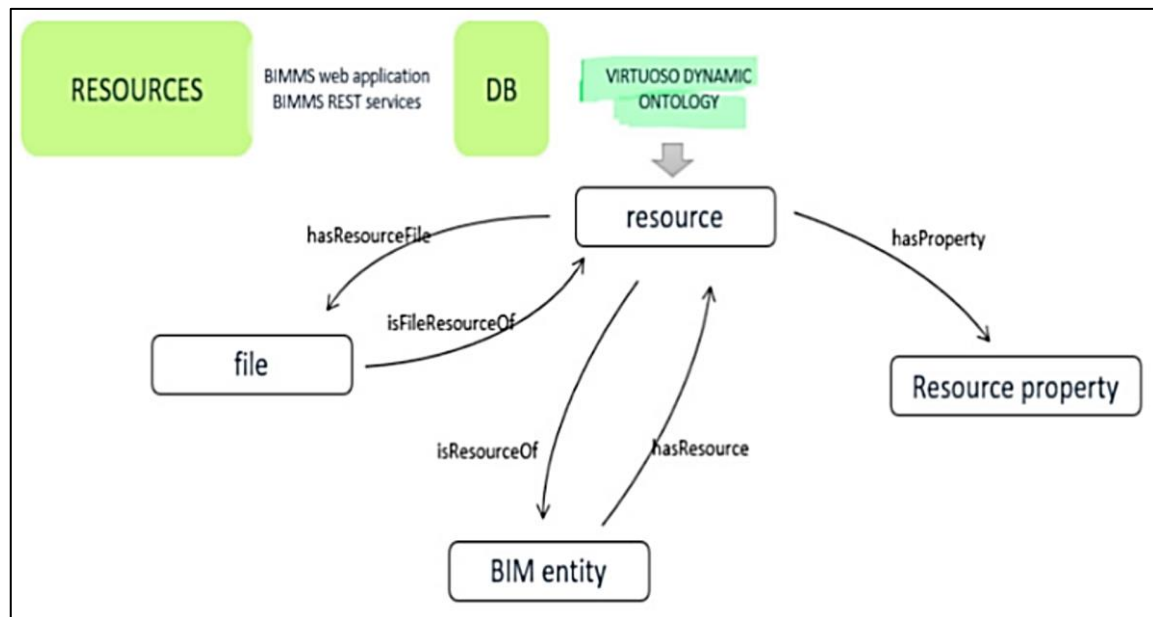


Figure 1.3: Major Resources Used in The BIM Techniques [66].

1.3 RESEARCH SIGNIFICANCE

This work comes with several distinct relevance's. It comprises theoretical, methodological, and practical significance. Firstly, this research has a theoretical significance through which the knowledge and information regarding critical consequences of construction projects' delay issues are expanded and broadened. Also, the theoretical relevance will lengthen the literature review regarding effective approaches and intelligent methods that can be adopted and implemented to minimize and alleviate this issue in the construction industry. Secondly, this study comprises the methodological significance by which cross-sectional descriptive quantitative research is applied using an online survey questionnaire that can help collect considerable primary data from different Iraqi top managers, senior engineers, project managers, and project management experts without the need for meeting them personally, which can save remarkable levels of effort, time, and cost for the researcher. Thirdly, this research contains a practical relevance, as beneficial guidelines and effective frameworks are proposed and investigated to help researchers, scholars, and students conduct further analysis and find practical solutions that can mitigate the delay problem and its consequences in the construction sector.

1.4 THESIS CONTRIBUTIONS

The theoretical contributions of this research lie in the following:

- i. To enrich the literature review with major adverse consequences related to the delay problem when it occurs in the construction project.
- ii. To validate and explore several solutions and intelligent approaches that can alleviate and minimize the delay problem in the construction sector, thus, reducing financial losses and other associated risks.
- iii. To employ a descriptive quantitative cross-sectional study via an online survey questionnaire, saving a significant degree of time, effort, and cost to gather primary data regarding effective practices and solutions to mitigate the delay risk.
- iv. To conduct further research and development (R&D) work on functional and beneficial project management principles and applications that can resolve the delay issue in construction projects.

Further, the practical contributions of this research can be categorized into the following articles:

- i. The need for intelligent methods and innovative approaches that can be adopted and implemented to help top managers and project managers resolve the delay issue in their projects.
- ii. The requirement for higher performance practices and policies that can be followed and applied to reduce adverse consequences and harmful effects of delay in the construction sector.
- iii. The necessity to help project managers, senior engineers, and other stakeholders manage the budget and submission time of their projects avoiding the delay issue that can cause different undesired impacts.

1.5 RESEARCH MAJOR AIM AND MINOR OBJECTIVES

This research's major aim is to investigate and assess some successful practices and solutions that can be embraced and executed to minimize the delay problem and its associated risks to the project managers and other parties. Besides this major goal, a group of minor objectives are executed to accomplish the thesis's main goal, which is presented in the following paragraphs:

- a. To shed light on major reasons and causes of delay problems and their dangerous consequences and adverse impacts on the construction project.
- b. To identify and locate some practical solutions and beneficial practices that can be applied by project managers to solve the delay problem.
- c. To carry out a descriptive quantitative cross-sectional study through which the opinions of project managers and construction experts can be assessed and predicted regarding effective practices and successful procedures to resolve and reduce the delay problem in construction projects.
- d. To apply an online survey questionnaire to collect primary data related to the thesis topic.
- e. To validate, modify, and adjust the results according to a panel of project management experts' and construction professionals' points of view.

1.6 RESEARCH QUESTIONS

The work is conducted to examine critical practices and functional solutions to help adopt by project managers, contributing to the reduction and resolution of the delay problem. The research's statistical analysis will offer some answers to the research questions, which are presented in the following articles:

- a. What are the primary drawbacks and detrimental effects of the construction industry's delay issue for all parties involved?
- b. Could the implementation of effective practices and functional solutions reduce this delay problem?
- c. What are the critical opinions and points of view related to top project managers and project management experts regarding the mitigation of the construction projects' delay issue?

- d. Can their solution be effective and beneficial in alleviating the delay of construction projects' submission?

1.7 RESEARCH HYPOTHESES

This research is conducted to examine various critical solutions and beneficial practices that can be adopted and followed to reduce the delay problem in construction projects. The validity or invalidity of the study hypothesis will depend on the statistical findings of this research. These hypotheses are shown in the paragraphs that follow:

- i. Null Hypothesis, H_o – which assumes that: “The delay issue has no adverse impacts or negative consequences on the construction project.”
- ii. Alternative Hypothesis, H_a – which assumes that “Solving the delay issue can improve the clients' and stakeholders' satisfaction.”
- iii. Sub Hypothesis, $H_{a,1}$ – which assumes that: “Implementing effective practices for project managers can help alleviate the delay problem in different construction projects.”
- iv. Sub Hypothesis, $H_{a,2}$ – which assumes that: “Adopting and following functional policies and practical solutions for project managers can help them reduce the financial losses due to the submission delay.”
- v. Sub Hypothesis, $H_{a,3}$ – which assumes that “Employing effective practices to alleviate the delay problem helps project managers manage the risks and control other parameters in the construction project flexibly when the delay occurs.”

1.8 THESIS STATEMENT

The title of this study is “Losses Resulting from Exceeding the Specified Time for Completion and Its Impact on the Status of The Project and Delay in Utilizing Services.” This research is executed to investigate and examine some technical solutions and functional strategies to allow project managers to reduce financial losses and manage risks that can occur due to the delay problem in the construction project.

1.9 THESIS ORGANIZATION

The layout of this thesis includes five chapters. These chapters will cover several topics and key ideas associated with the delay problem in construction projects. The thesis layout can be summarized through the following articles:

- i. Chapter One, with the title of INTRODUCTION, describes important data associated with the study background, problem statement, study significance, research questions, hypotheses, and research's major goal and minor objectives.
- ii. Chapter Two, which has the title of LITERATURE REVIEW, discusses significant examples associated with the critical consequences and adverse effects when the delay problem takes place in the construction project. In addition, chapter two addresses substantial solutions and critical practices that can be adopted and applied by project managers to improve the construction project submission performance and reduce delay. Chapter two will collect the data from publications found in master and PhD dissertations and web research engines, including ResearchGate, ScienceDirect, Academia, and Google Scholar. Also, several conference proceedings will gather a database on the critical solutions for the delay problem in the construction sector.
- iii. Chapter Three, which has the title of RESEARCH METHODOLOGY, illustrates the major approach and methods conducted and followed in executing this study. Also, chapter three explains critical study variables and parameters that will be assessed and tested via the descriptive cross-sectional quantitative study via the online survey questionnaire.
- iv. Chapter Four has the title of RESULTS AND DISCUSSIONS. This chapter presents major thesis findings associated with the statistical analysis of the descriptive cross-sectional quantitative study and the results of the online survey questionnaire responses. Furthermore, chapter four describes the research discussions which relate the research's major outputs to other scholars' findings.
- V. Chapter Five, which has the title CONCLUSIONS AND RECOMMENDATIONS, indicates the main study's conclusions linked to the research findings from the descriptive cross-sectional quantitative study. Further, chapter five illustrates a set of recommendations and key suggestions related to future work to provide critical

solutions, practices, and ideas for project managers, engineers, and other stakeholders to solve the delay issue in construction projects.



2. LITERATURE REVIEW

2.1 AIM AND INTRODUCTION

Chapter two addresses remarkable illustrations linked to the critical consequences and adverse effects when the delay problem occurs during the construction phases. Additionally, chapter two provides detailed answers and essential techniques that project managers can use to speed up and improve the performance of construction project submissions. In Chapter 2, information will be gathered from publications contained in PhD and MA theses as well as from online databases like Academia, Science Direct, Google Scholar, and Research Gate. Further, a number of conference proceedings will compile a database on the crucial fixes for the construction industry's delay issue.

2.2 CRITICAL IMPACTS AND REPERCUSSIONS OF THE CONSTRUCTION SECTOR DELAY PROBLEM

[67] Investigated the relationship between conflicts and delays that occur in construction projects and negatively affect their performance. The researchers depended on a comprehensive literature review through which 172 recent publications and studies were addressed and reviewed to determine the primary reasons for the delay problem in the construction industry. It was found that several countries face the delay problem in different construction projects, which are illustrated in Figure 2.1.

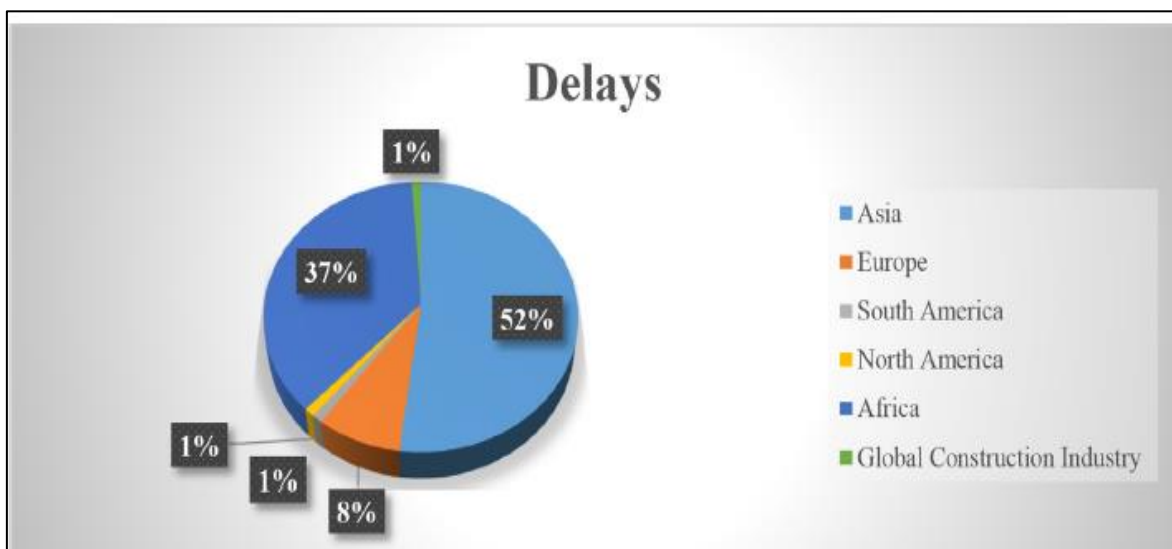


Figure 2.1: Geographical Distribution of Studies Reviewed For Delays [67].

It can be noted from Figure 2.1 that the delays are ranked in Asia at 52%. At the same time, Africa had a ranking of constriction delay with 37%. In comparison, Europe had the lowest at 8%. They found that one of the major delay problems is due to conflicts occurring in various countries, not in certain nations. Figure 2.2 illustrates the number of conflicts in different continents that correspond to the delay issue.

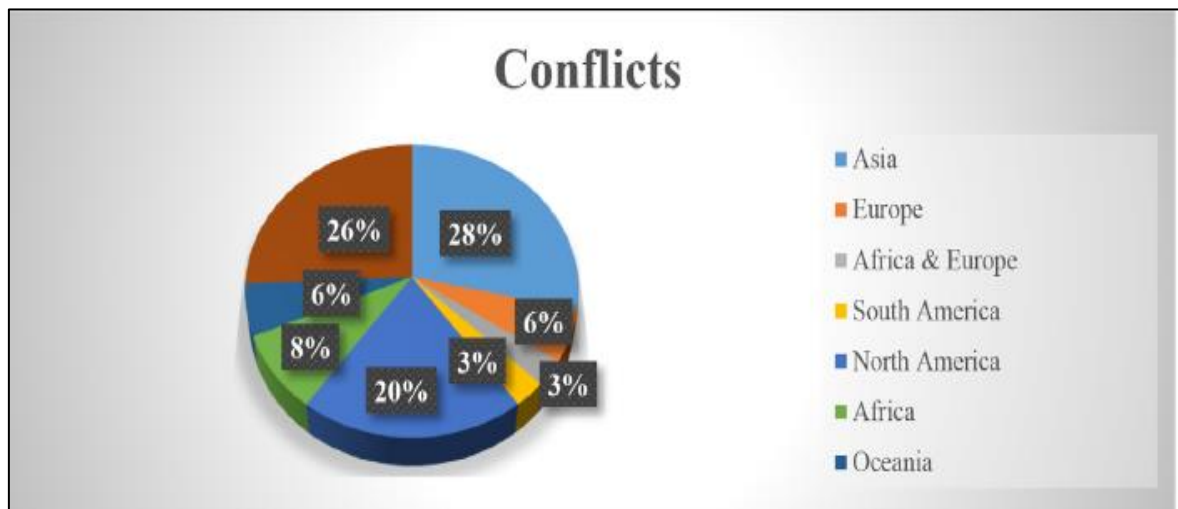


Figure 2.2: Geographical Distribution of Studies Reviewed For Conflicts That Cause The Delay [67].

It can be noted from Figure 2.2 that the conflicts in Asia correspond to 28%. They correspond to 20% in North America. At the same time, Africa had the lowest percentage with 8%. One of the vital results of the research is to identify the most critical reasons for delays in engineering projects, which are the occurrence of financial problems from the owner, the issue of project planning, the weakness and scarcity of materials, the changes that occur and the lack of communication between the parties to the project. As for the conflicts, the five reasons were the changes taking place, financial problems, and delays in construction, problems related to the terms of the contract, and poor communication between the parties involved in the project. As for the reasons related to design and modernization, they were classified into three reasons: the differences that occur, the poor relationship between the project parties, and the financial problems that occur. [68] guided a study identifying the risk factors that lead to delays in projects, which clearly and significantly affect the construction

operations in the Aceh region in Indonesia, which is witnessing a significant delay in the implementation of construction projects, as the delay in construction leads to fines and losses, which called for the need to know these factors that affect the progress of the project. The study was in the form of a questionnaire distributed to 68 people, and this evidence contained reliability tests and tests of validity. As a result of this study, 60 delay factors were concluded, where 30 were placed as a high-impact risk indicator with a typical value ($=5$). In comparison, 29 factors were dangerous delay indicators with A high effect of $=4$, while the remaining one indicator had a medium impact of 3. This study provided important information about the factors that lead to delays during the implementation of projects in Indonesia for consultants, contractors, and the supervisory authority. A successful project within its limited time, with high quality and low costs, is essential for planning any construction project. Contractors must thoughtfully implement projects within the time limits specified for it, avoid fines resulting from delay, try to complete the project as soon as possible, and try to reduce costs through successful project management within the specified time. This research was studied in Indonesia on 68 people and cannot be generalized to other countries and regions. Therefore, when investigating this work in other countries, the number of people surveyed must be increased for the study to be more comprehensive. [69] Led an exploration investigating major delay factors of construction scheduling and project analysis in Malaysia by knowing the main and primary reasons for project delays and identifying the main factors for them. For that, they analyzed 52 main reasons for delay after taking the opinions of 148 contractors, clients, and consultants in Malaysia and after the analysis, they ranked 20 reasons. They were relied on by contractors, clients, consultants, employees, and many related causes. They arranged the reasons according to risk importance and frequency. The five main reasons were:

- a. Frequent change of clients,
- b. Lack of qualified sub-contractors,
- c. Poor planning as well as poor supervision,
- d. Lack of specialized site management,
- e. Financial problems that occur to contractors.

The author used Spearman's analysis and found good agreement among respondents to better document the results. The main factors delaying the schedule have been identified. These aspects include:

- i. Coordination and communication management
- ii. risk management
- iii. financial management
- iv. site management
- v. capacity and efficiency management

By analysing developing countries for comparison, the critical reasons contained poor contractor competence, lack of awareness and inability to deal with problems that occur in project management. The researchers recommended conducting permanent and extensive studies to understand the reasons that led to the delay, focusing on the five main causes that disrupt the project schedule and addressing them appropriately, training and educating construction professionals to protect their ability to tackle problems and increase their awareness. All this contributes to a better organization of project management. Also, the study provided good insight into improving project management, avoiding delays in project delivery, sticking to schedules, and better organization and employment of project management. [70] reviewed a problem that is apparent in all developing and developed countries, which is the problem of construction delays, which costs billions each year. The review identified 35 common delay factors in the construction sector. The ten most important factors were:

- a. Owner changes to the scope or variation orders during construction,
- b. Consultants' errors and contradictions in design documentation,
- c. Governmental control and authorization for permits,
- d. Owner funding and compensation for finished work,
- e. Contractor's poor planning and schedule,
- f. Owner's hesitant choices,
- g. Incomplete drawings, insufficient information, late issue of instructions, information, or drawings, as well as delays in design work, design document revision, and approval of works or materials,
- h. Issues with project coordination and communication between participants,

- i. Construction issues with mechanical and electrical subcontractors,
- j. Unfavorable weather.

The primary causes of delays between the two nations are sluggish decision-making on the part of the owner, poor contractor planning and scheduling, late delivery or a shortage of building materials, an unskilled workforce, government rules, and permit acceptance.

The researcher presented proposals for the necessary measures to reduce construction delays, such as holding organized meetings between the owner and consultants and between the owner, consultants, and contractor. Also, permanent follow-up should be made to raise the level of professional standards for consultants, in addition to establishing a training center for the construction industry and the need to possess a skill assessment certificate for employment in construction projects to increase the skills of construction workers. The researcher stated that there is a solid need to stress the UK contractor registration system related to the required expertise and paid capital. For contractors, it is necessary to professionalize the project team. Moreover, the researcher saw that the improvement in the commitment to the construction works planned in Portugal, the United States and the United Kingdom depends on the extent of commitment to implement the proposed measures. Further, the researcher recommended the use of these measures in countries with similar construction environments to these countries and which have the same major delay factors. [71] conducted an investigation on the main important factors that lead to delaying projects in Hargeisa, Somalia, by adopting construction projects and the road as a preliminary study, as the delay in construction is one of the essential recent studies that affect the quality of projects. It is one of the most severe and costly problems for private projects. This study was conducted by conducting a questionnaire with 51 factors of delay, divided into seven main groups. Random samples were selected from several construction companies, and data were collected from 51 key persons associated with the construction. This study showed the main factors that affect the delay of projects, and the delays associated with contractors are the most critical impact of the delay in construction. Also, it was found that the delay related to the owner comes, followed by the delay associated with the consultants and the delays received with materials. As for the delays related to work, equipment and external factors, they are the least significant delays. Using the relative importance index for rating purposes

(RII) and analysing the responses from the respondents, the results showed that the three critical reasons for delays affecting construction projects in Hargeisa are:

- a. An increase or decrease in the project cost estimate.
- b. Not taking the approval to make significant changes in the project promptly, thus causing a delay.
- c. A gradual delay in payments.

Appropriate project management procedures must be used to control 16 dangerous delay factors when undertaking future construction projects. These results are considered essential for future projects when they are well taken into consideration. Besides, more attention is paid to applying critical project management tools such as risk management in construction projects and good sourcing. The initial and gradual payment of contractors by the owners is one of the appropriate measures to reduce delays and increase the contractor's ability to promptly obtain the required quality. Contractors must study project management principles well to avoid and reduce delays. The consultants must ensure communication between the client and the contractors, as they are the mediators between the parties to the project, reducing the project delay process. [72] Conducted research into the causes of construction project delays related to the customer and their relationship to the main characteristics of the projects and shed light on the major causes of the delay problem, which may affect the vision of projects in 2030. The study analysed 37 projects for three different ministries of the public sector, namely, the Ministry of Rural and Municipal Affairs (MOMRA), the Ministry of Health (MOH) and the Ministry of Education (MOE) that took place over ten years between 2007-2017. Data was extracted manually for these projects, and a descriptive statistical analysis was conducted for them. Fixed models such as the Cost Performance Index (CPI) and Schedule Performance Index (SPI) were used. The correlation index, i.e., the inferentiality of the social sciences in the statistical package (SPSS), was also employed. The authors used the dot-sequence binary correlation coefficient (rpb, where $p > 0.05$). To know the correlation between delay and project performance and cost overrun, they identified the major critical factors based on the SPSS. The results of the study showed eight critical reasons for the client-related delay from 0.84 and 0.89 on the CPI scale, in addition to the SPI index with values ranging from 0.71 to 0.82, and this indicates a weakness in two main things, namely cost and time. The most crucial delay factor is the change order, which occurs

at a rate of 81%. The rest of the reasons that happened at a rate of 54% are poor communication between the parties to the project, a delay in the payment process, and ineffective planning of projects. These reasons were examined in 20 projects (out of 37). As for other reasons, such as errors and differences in design, it was 30%. The delay in approving the bill of quantities, which was modified, was 16%, and the delay in starting projects was 8%. The last factor, the lack of funding from the client to complete the work, was 3%. The strong correlation between the eight causes of delay related to the client with the main characteristics of the project, such as time, additional duration, cost, and additional cost, helps the client to reduce delays and understand their causes well. [73] Published a manuscript that explores the problem of building projects in Egypt are being delayed, where the delay is one of the most critical problems facing projects in Egypt. One of the most important reasons for the success of projects is the completion of the project on time within the required cost and specifications, so it was essential to develop and find A program that helps assess the reasons for the delay. The design was designed to minimize potential mitigation effects and Building Information Modeling (BIM) was the best way to do such an analysis. Figure 2.3 shows the case study in this paper.

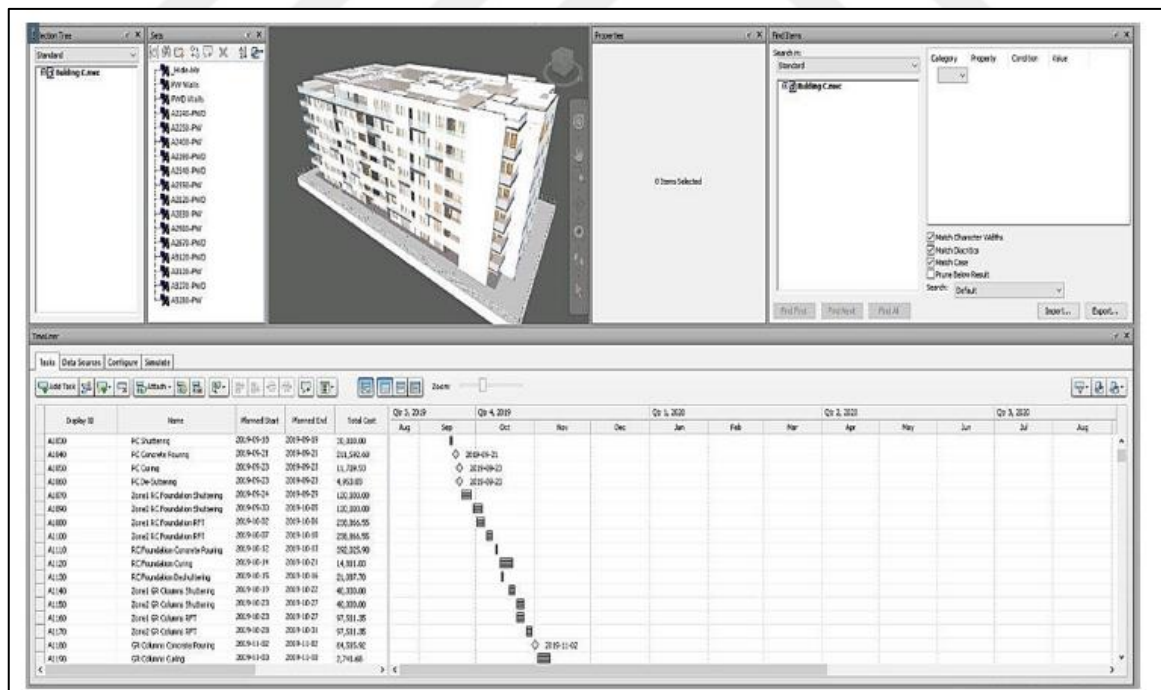


Figure 2.3: The Navisworks User Interface Displays The 5D BIM Model for The Case Study Project [73].

This program has succeeded in evaluating the cost and impact of the project on its duration by researching several vital factors related to the projects. The analysis included determining the cost and time of projects according to the various delay causes and trying to mitigate them. Therefore, the critical objective associated with their work was to search for the reasons for the delay in the project duration and cost, to support the user in knowing the causes and types of delays, and to know the appropriate measures to mitigate them. One of the results of this research is the development of a table summarizing the duration and cost of making the real decision regarding the delay. These results were among the main and essential indicators that should be referenced during the project's life. One of the most important results of the study is that the program was able to analyze the cost and duration related to the reasons for the delay, and the percentages were determined. As for internal activities such as changes and placement of change orders during construction, the rate associated with delay claims was 15.1%. As for cost savings, it was 1.2%. As for the rest of the reasons for the delay, including (the poor level of workers' production, the owner's delay in payment, and the lack of equipment needed for construction), the decline rates for late claims were 0.3% for the first, and 1.3% for the claims. The second reason, and 1.1% for the third, while the savings rates were 0.1% for the first and 0.3% for the second and third. The external causes are out of control and difficult to control. [74] executed a study identifying the factors that lead to delays in construction projects in Qatar and focused on ways to mitigate these factors, as three categories of buildings, worship buildings, commercial or office buildings, and four or five-star hotels were studied. The main objectives of studying these categories are to know the relationship between the characteristics of projects and delay factors to mitigate and reduce them. This study assumed that the projects in the State of Qatar, due to the difference in their implementation, require a high cost per square meter, as interviews were conducted with experts specialized in the project and a case study. The study showed that for complex projects, the changes are large, while the delay is smaller for less complex projects. The study confirmed that knowing the delay factors early for project management ensures good performance on time, as a framework was formed to compare performance for four categories of projects, identify three risk factors, and know the weight of each of these factors concerning the total delay and how these things affect the scheduling. One of these factors is the delay due to the inspection by the authorities and changes in the foundations of the project, and this leads to two main results: the strong influence of

stakeholders on the performance of the project and the changes and delays that occur in the final critical stage corresponding to the delivery stage. It is necessary to know the possible causes during the construction process and identify the risks that lead to them in small and large projects to reduce and mitigate these risks. The data collected during the study found that many companies are weak in risk management. Therefore, to avoid potential delay, tools must be designed for the characteristics related to the project, such as importance and complexity. The size and the proper management of knowledge must be transferred to the company's culture. [75] Conducted a systematic study to investigate the causes of delays in construction projects, know them and work to mitigate them by conducting a comprehensive analysis of 97 types of research. Through this research, 149 causes of CPD were identified. The ten most common programs among CPD programs were identified: the lack of coordination between Persons associated with the project, poor planning and lack of materials, financial problems, bad planning, insufficient competencies, and lack of labor. The results of this study showed the weakness of project schedules, and this leads to problems in projects in developing countries, which identified the reasons for impeding the plan, such as human resources, in addition to material causes, and this was confirmed by 20 documents that were examined. Also, these problems that arise from off-site manufacturing were not observed in the research that has been studied. To improve the performance of the schedules, it is necessary to know each reason that leads to the delay and treat it, as the major reasons that lead to the delay are searched, and the effects of the impact of these factors on each other and the impact of each factor separately on the schedules are discussed. One of the procedures the research recommends is that the completed project be delivered within the specified time, reduce waste, and carry out the building information modelling process. Concerning how to have the project was not addressed in previous research. [76] led a study identifying critical characteristics related to delays in construction projects by adopting residential projects in the study in India, where construction is one of the main vital factors in the growth of the economy in India, where the schedule and low cost are the main challenges of building in India. A study was conducted on contractors and consultants using the Materiality Index (RII). The results showed the significant reasons for project delays in India: poor procurement planning, lack of materials at the work site, frequent return of work, difficulty in accessing the site, changes in weather conditions, inadequate equipment and scarcity of consultants and contractors. The RII analysis is between eight critical factors,

how these factors relate to each other, and how these factors are directly responsible for the delay problem. By adopting the RII method in factor analysis, the factors related to management are considered the most important, as they contribute 42% to the delay of projects. Among the management-related factors are the delay in approving all executive plans, the lack of coordination between all teams, the delay in finalizing all items, and the lack of procurement planning.

2.3 EFFECTIVE PRACTICES AND PRACTICAL SOLUTIONS TO MITIGATE THE DELAY PROBLEM IN THE CONSTRUCTION SECTOR

[77] offered the mitigation controller to illustrate and enhance searching for the most helpful delay mitigation methodology in construction projects. The Mitigation Controller (MitC) gather the Manual Program Evaluation Review and Technique (M-PERT) scheduling program with Monte Carlo representation to develop the project achievement possibility curve. The MitC deletes the modelling fault in the popular delay mitigation methodology by reflecting the individual control action in the suggested model. It considers many necessary modelling sides while discovering the ideal mitigation. Methods like stochastic changes in the activities periods, mitigation abilities (i.e, mitigated period) and mitigation cost were employed. The writers also take into account potential risks that can affect how long the project takes to complete. Additionally, by utilizing these many sides, the MITC enhances the problem by incorporating achievement charts and capturing the relationships between the appropriate intervals. The MitC returns a realistic simulation of the project's potential for timely emulation. The mitc provides a reasonable estimate of the project's chances of finishing on schedule. The MitC was created with a variety of users in mind, including researchers, project managers, and students. The program can be used by these target groups and customized to meet their needs using either the enhanced GUI or the open-source code. It was established that standard construction planning is excessively rigid in terms of the number of necessary mitigating factors, which drives up costs. Furthermore, it was proved that the adopted penalty/reward chart identifies the ideal achievement date of the project. The MitC prevents selecting traditional distributions in the Monte Carlo distribution. Additionally, the program supposes unlimited employers and material references when choosing mitigation factors. [78] Discussed the situation of the construction sector in Bangladesh, which suffers from delays. For this, they provided a solution to the main delay

factors associated with the construction sector by setting a framework for the pre-construction phase of the project and the project implementation phase to reduce these delays as much as possible. This aspect is based on the fourth dimension (4D) of Building Information Modelling (BIM). The researchers conducted a literature review of previous studies to analyse the delays in many countries, including Bangladesh. Accordingly, the framework was developed through a realistic simulation of a construction project that suffered from delays due to poor design and planning, based on the Autodesk Navisworks Manage program. Using Building Information Modelling mitigates delays in the pre-construction phase of identifying a design error before construction begins by utilizing the Clash Detective tool at Navisworks in the implementation phase, comparing the necessary progress of the project during a specific period with the actual progress of the project on-site using the 4D Time Liner tool at Navisworks. Positive results were observed by comparing the mode with and without BIM. To validate the effectiveness of the study, a case study was considered. The results proposed in the framework were matched with the case results. The researchers found that when applying the proposed framework in the pre-project stage, the project reduced the possibility of errors by checking the model several times according to the framework. Figure 2.4 shows the number of inconsistencies in the design model.

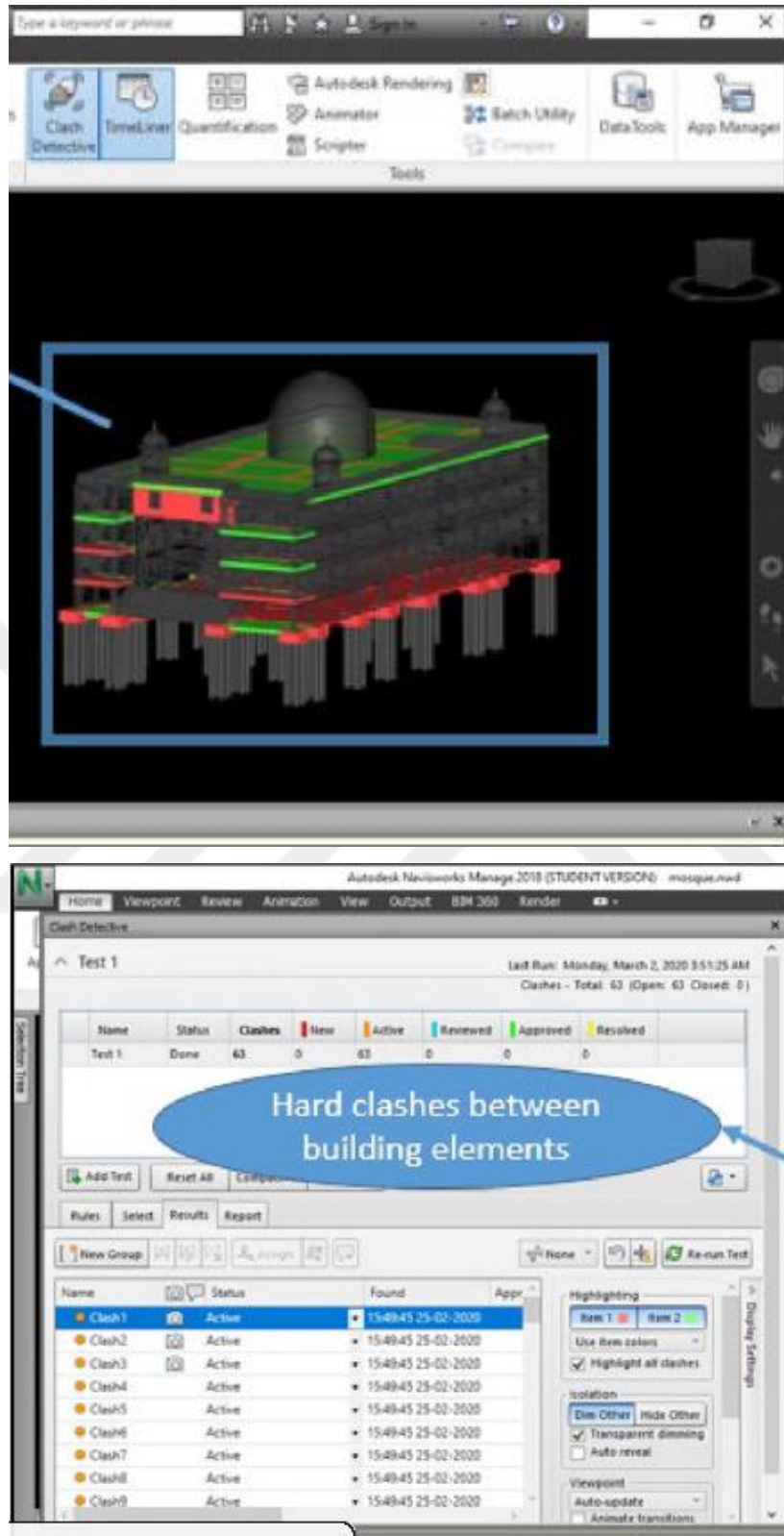


Figure 2.4: List of Clashes Exposed By Clash Detective [78].

As for applying the framework to manage the delay in the implementation stage, which is the most difficult, they found that using the 4D Time Liner tool can help reveal the reason

for the delay. Then the project manager must take the appropriate action to complete the construction process. Figure 2.5 shows the required works until the date indicated in the image.

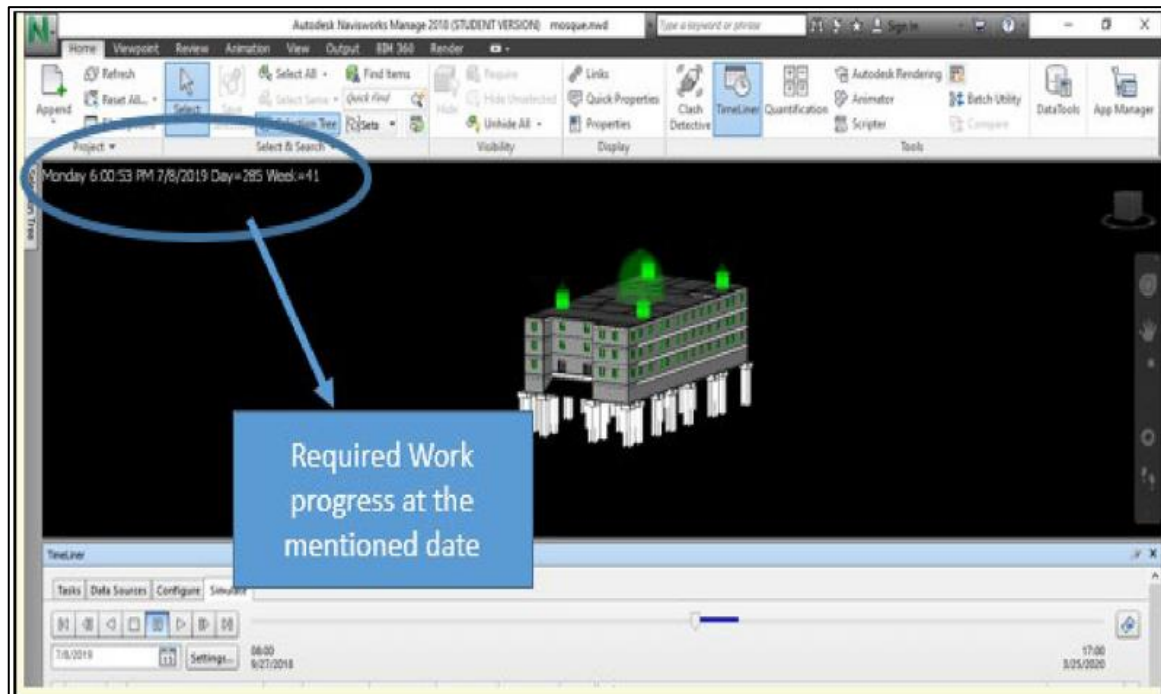


Figure 2.5: The required work progress obtained from the 4D Timeliner simulation [78].

The researchers recommended that project managers use the framework to track the project in the implementation phase and designers in the pre-construction phase to validate the design model. The productivity of the project will increase if the traditional methods of preventing construction delays are combined with the 4D BIM approach. In Bangladesh the researchers recommended giving importance to getting to know BIM technology by coordinators, supervisors and engineers. Most companies do not adopt this technology in their work by holding scientific seminars or sending qualified employees for training abroad. The researchers considered that this framework is applicable to the local construction industry and can be used at the international level and applied in countries with a building environment close to Bangladesh, such as India and Pakistan. [79] Explored the issue of time and expense overruns for a variety of causes, but the two most significant ones are inadequate project planning and scheduling and erroneous bills of quantities. This aspect is not acceptable in the construction industry, so solutions should be sought to reduce the risks. They have been delaying time and cost overrun since the beginning of project planning, especially in facilities with complex structures such as stadiums. The study suggested relying

on Building Information Modelling (BIM) in its fifth dimension (5D) with the (M-PERT) method to try to reduce risks. The (M-PERT) method is the model developed from M-PERT method. This technique has proven its ability to control and save time, while Building Information Modelling (BIM 5D) has proven to reduce costs by (43%). To determine the effects that identify the success level related to improvement (5D BIM and M-PERT), the researchers conducted a survey distributed to construction industry practitioners in Indonesia and directed specifically to those who worked in stadium implementation, and then analysed the results of the questionnaire by RII method to rank the main and sub-factors-influencing the success of the 5D BIM and M-PERT approach. Figure 2.6 shows the influence relationship between the research purpose and the main factors for successful improvement.

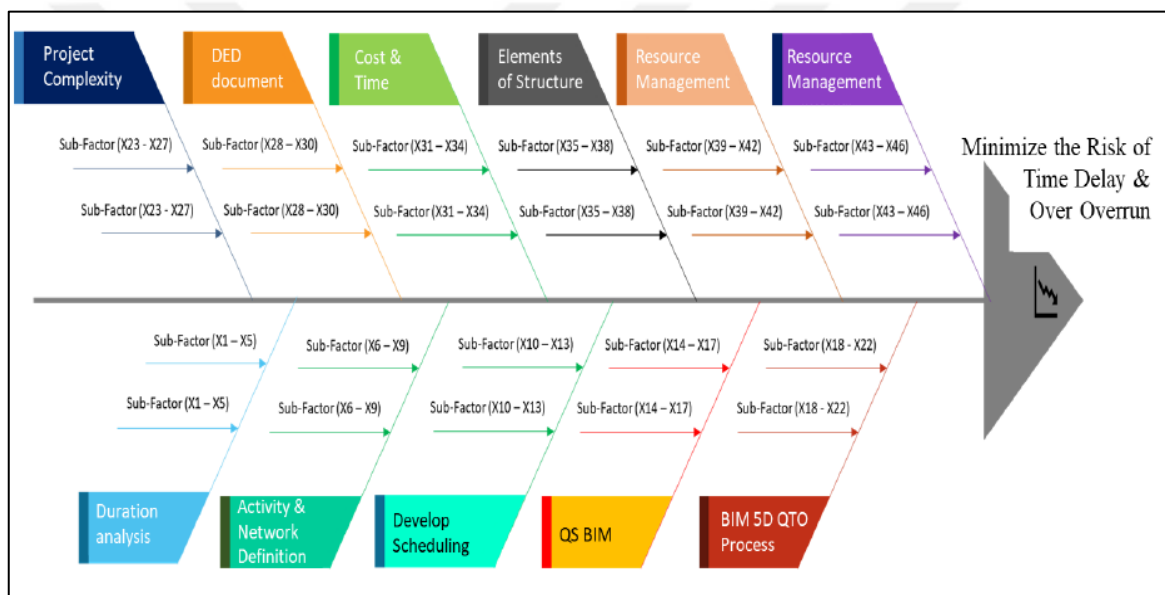


Figure 2.6: Principal Factor and Subfactor Category for Successful Optimization of M-PERT and BIM 5D [80].

The researchers found that the most influential factors on the effectiveness of improving 5D BIM and M-PERT to reduce the problem of delaying time and increasing budgets, especially the structural works of stadium projects, are:

- Scope, timetable, and budget that are unrealistic,
- Reduction of the activity network complexity,
- Combining and merging projects,
- Higher degree of precision between plans and results,
- Complexity of structural design,

- f. Details of 3D modeling,
- g. Quantity Take-Off,
- h. Clear requirements and detailed drawings,
- i. Accuracy of the bill of quantities,
- j. Difficult installation methods.

[80] did research work in the important construction industry where many problems lead to time delays due to many factors affecting construction projects, and to overcome this problem, the causes leading to delay must be faced. A theoretical review was conducted for previous research that dealt with the main criteria for reducing delays. The result of the review was that there were 143 ideas to minimize the delay, the most important of which was 27. Then they were categorized based on the essential elements in construction into four main criteria to mitigate the delay, which are: First: Management, including the idea of proper management promptly, control of the construction project, and financial management. As for the third: is the technical matters that are based on the correct selection of skilled and colorant labor and the presence of a competent contractor to conduct a project and a technician that guarantees the quality of the construction project, and fourthly, technology: by following modern methods of tools and programs in construction, which increases the rate of construction, which affects productivity. This study helps to enable the participation of construction parties to focus on the element to identify problems and apply ideas to reduce delays in the construction project. [81] Discussed the construction project failures due to time delays and cost overruns, which have high financial and social costs to the public. Hence, their study looked at schedule estimation errors that are still frequent in the execution of significant public procurement. The complexity of the projects, length of the phase of implementation, and the degree of cost overrun (or low cost) can all make it worse in terms of frequency, size, and characteristics. The study found a contradiction between reality and assumptions due to significant uncertainty when investing in infrastructure, which causes delays. In time and cost overrun, for example, in the Big Dig project in Boston, the estimated cost was \$2.6 billion, while the final cost was \$14.6 billion, with a delay period of 8 years. Despite the efforts made to improve the performance of the schedule in the United States and the United Kingdom, they failed, so to address the problem, it was proposed to predict the reference category to mitigate the optimism to deal with the complex issues in the schedule estimates as well as in the cost estimates. Since the reference

category forecasting implementation, cost overruns for UK transport projects have shown a difference compared to schedule delays. Average schedule delay decreased from 21.0% to 26.0%, and average cost overrun reduced from 38.0% to 5.0% in the UK, with the frequency of underestimation becoming statistically less frequent in cost estimates 46.0% than in schedule estimates 77.0% From UK projects. [73] Developed a methodology divided into two essential parts: an organized processing framework and a survey questionnaire. The first part was illustrated utilizing scheme characterization “flow chart,” which is consecutive order and helps analyse the delay reasons for structural projects in Egypt. Many delay reasons were prepared in the questionnaire, including delayed decision-making, lack of construction materials and labour, poor site management, and faults in project files. The survey questionnaire was achieved to gather objective data. The essential purpose of the questionnaire is to guess the delayed construction projects reasons in Egypt and their influence on the total project period. Additionally, they examined the BIM approach participation in Egyptian structural manufacture and studied its impact on construction project delay and cost impact. The findings supported the use of a methodical processing framework to explore the causes of building project delays in Egypt, with survey questionnaire answers serving as a backup. This method helped to prioritize delay reasons and contributed to determining the most appropriate methodology for handling structural project delays and their related cost influence. Moreover, this approach benefits construction structures like suburban buildings and hotels. [82] Researched the remarkable reasons for construction delay in long-structure projects, using a model that could simplify delay hazard assessments in tall building projects. In enhancing the delay risk model, 36 delay hazard factors were selected. The analysis found that the most impacting factors of delay contained delay in decision making, slowness because of contractor job, delay in identifying the supervising engineers, and delay in getting shop drawings. Manufacturing experts’ data related to these factors improved ANN’s categorization model. It was concluded that the best achievement degree is 93.75%, corresponding to a higher degree of accuracy. This research showed that machine learning is an appropriate methodology for improving models that can quality guess the hazards of delays in tall building projects. It could be affirmed that the model improved in this research can efficiently supply hazard-based decision taking in long structure projects. Even though the model relies on data from long-structure experts in the GCC area, the methodology utilized can be suited to other global climates. [83] Intended to

investigate whether factors lead to construction delays in India, which suffers from many delays in projects for several sectors such as transportation, water and building construction, and to compare the Design of Bid Building (DBB) projects and Building Design (DB) regarding the delay causes and work to reduce them. This was done by conducting a survey among contractors, consultants, and clients in India. The significance index was applied to rank the reasons for the delay in order of importance. The projects were categorized according to their awareness, and reasons for the delay were identified. The studied public sector projects also were grouped according to the kind of current contract and the comparison in the causes of delay between DDB and DB and statistically analysed using one-way analysis Cronbach's alpha and Kruskal-Wallis model lined to machine learning principles to evaluate the delay issue associated with high-rise construction projects test and to devise mitigation methods interviews were conducted with large figures of industry professionals. The results of this study indicated the reasons for delays in projects in India, the most important of which is the reason related to project financing, and also the reasons for disputes on the part of the owner and delay in payment when there is additional work and changes / during the construction process by the owner, and making a change in the design process is one of the reasons for Comparing the reasons for the delay in the DB and DBB methods, the researchers did not find clear and significant differences between the two ways. This research is one of the recent and first studies that examine the causes of delays within one country and for several different projects. This research is also developing timelines and reducing delay causes, especially in developing countries, by comparing delay causes that occur in DB and DBB methods. [84] Guided a study to improve machine learning models to simplify precise project delay hazards analysis and foretelling utilizing target data references. Consequently, the delay factors were determined. The dataset containing various references to past projects' time achievement and delay-causing hazards was subsequently gathered. An analysis of exploratory data was then used to reveal the system's intricacy and connections. As a result, two suitable machine learning models were identified, trained, and used to use the data set for project delay range prediction. These models used a decision tree and naive Bayesian categorization mathematical technique. Lastly, utilizing achievement metrics linked to machine learning, the foretelling performance of both models was evaluated by cross-validation testing. This study was conducted by achieving two key targets. First, the basic impact hazard factors and references influencing construction project

delays were determined using a literature survey and interviews with construction field experts. Also, a data set, including earlier building projects' range of time overruns and the related contributions of hazard references, was collected through interviews with construction companies. During this operation, many key limits were considered to ensure data consistency and efficiency. Moreover, discovery and sensitivity data analysis led to an agreement on the complicated behaviour of the construction field and the linkage between the several delay hazards references. It was concluded that the naïve Bayesian scheme gives a better foretelling achievement for the set of data checked. Moreover, the work presented employs the energy of ML to simplify taking decision operations dependent on proofs. While hazard factors are energetic, linkage, and dynamic, it confirms proactive project hazard management methodologies. [85] Research was conducted to improve a work plan to exceed restrictions of previous methodologies to guess hazards in excavation projects; every year, excavation works are completed, and these works influence delay and increased cost of project execution. So, determination and guessing of the dangers of these events were necessary. When finding solutions for project management assignments, it is essential to determine the fundamental hazard indicators of the projects. Managing these needs proper hazard mitigation methodologies to estimate and analyse their asperity. When finding solutions for project management assignments, it is essential to determine the fundamental hazard indicators of the projects. Supervising these requires proper hazard mitigation methodologies to estimate and analyse their asperity. The existence of information fault also causes limitations in performing Pareto quality. Hence, to ensure the balanced acceptance of all shareholders, hazard estimation of these projects can be considered as a necessary section of the multi-criteria decision-making (MCDM) process. In practical life, the estimation of project hazards is often unsure and even unfinished, and the predominant approaches fail to deal with such conditions. To solve the problem, researchers conducted the Analytical Network Process (ANP) approach in the D numbers range to deal with three kinds of unclear data: complete, unsure, and unfinished, and estimated the size of hazard criteria.

The D numbers dependent on methodology solve the limitations of the exclusiveness hypothesis and the whole restriction of Dempster–Shafer (D–S) theory. So, the decision matrix's inclination grade for each decision is identified using D numbers. Then (MABAC) approach in D numbers is improved to order and choose. The best substitute hazards

response methodology was used and analysed. Finally, a depicted case from the construction field is explained to examine the feasibility of the suggested method.

A comparative analysis is executed with various MCDM methods in the D numbers range for analysing the reliability of substitutive order. Depending on multiple criteria weights and sensitivity analysis.

Because of previous problems, including unfinished and inaccuracy, the suggested strategy can effectively simulate and deal with unsure data weighting hazards criteria and substitute reasonably way. An example of choosing hazard methodology in construction hazard projects is illustrated here to prove the quality of the suggested approach. The results showed that the estimate of a real-world application of the D-ANP-MABAC methodology, in addition to its output result of sensitivity, identifies its possibility to supply stable solutions in difficult conditions dependent on the suggested hazard methodologies alternatives are successfully classified.

Thus, it was revealed that the previous approach has provided an alternate methodology for sustainable hazard analysis and deciding in the construction field. Our proposed method considers both CFPR and ANP methodologies in the D numbers range.

2.4 Summary of the Literature Review Contribution

The literature review publications results reviewed in this work can be summarized in Table 2.1.

Table 2.1: Results of The Literature Review Publications Addressed in This Work.

#	Author(s)	Year	Paper Title	Major Contributions
1	Junaid Tariq, S. Shujaa Safdar Gardezi	2022	Study the delays and conflicts for construction projects and their mutual relationship: A review	One of the most important results of the research is to identify the most critical reasons for delays in engineering projects, which are the occurrence of financial problems from the owner, the issue of project planning, the weakness and scarcity of materials, the changes that occur and the lack of communication between the parties to the project. As for the conflicts, the five reasons were the changes taking place, financial problems, and delays in construction, problems related to the contract terms, and poor communication between the parties involved in the project. As for the reasons related to design and modernization, they were classified into three reasons, namely the differences that occur, the poor relationship between the project parties, and the financial problems that occur.

Table 2.1: Results of The Literature Review Publications Addressed in This Work. “Table Continued”

2	Anita Rauzana, Wira Dharma	2022	Causes of delays in construction projects in the Province of Aceh, Indonesia	As a result of this study, 60 delay factors were reached. 30 were placed as a high-impact risk index with a typical value (=5). In comparison, 29 factors were high-impact serious delay indicators = 4, while the remaining index had a medium effect = 3. According to the results of the research, contractors must thoughtfully implement projects within the time limits specified for them, avoid fines resulting from delay, try to complete the project as quickly as possible, and try to reduce costs through successful project management within the specified time. The researchers recommended that when studying this work in other countries, the number of people surveyed should be increased for the study to be more comprehensive, as the results of this study depended on 68 people.
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Table 2.1: Results of The Literature Review Publications Addressed in This Work “Table Continued”

3	Jeffrey Boon Hui Yap , Pei Ling Goay , Yoke Bee Woon , Martin Skitmore	2021	Revisiting critical delay factors for construction: Analyzing projects in Malaysia	This study provided good insight into improving project management, avoiding delays in project delivery, sticking to schedules, and better organizing project management. The researchers recommended conducting permanent and extensive studies to understand the reasons for the delay. Also, they recommended focusing on the five major reasons (frequent change of customers/ lack of qualified sub-contractors / poor planning as well as poor supervision/lack of specialized site management / financial problems that occur to contractors.) Correctly scheduling and processing the project, training and educating construction professionals to protect their ability to handle issues and increasing their awareness all contribute to a better project management organization.
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Table 2.1: Results of The Literature Review Publications Addressed in This Work “Table Continued”

4	Yue Choong Kog	2018	Major Construction Delay Factors in Portugal, the UK, and the US	The research suggested actions needed to reduce construction delays, such as holding structured meetings between the owner and consultants and between the owner, consultants and contractor. The researcher explained that there is an urgent need to confirm the contractor registration system in the UK with regard to the required expertise and paid capital, and for contractors, it is necessary to professionalize the project team. There must also be the constant follow-up to raise the level of professional standards for consultants, in addition to establishing a training centre for the construction industry, and the necessity of having a skill assessment certificate for employment in construction projects to increase their skills.
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Table 2.1: Results of The Literature Review Publications Addressed in This Work “Table Continued”

5	Adebayo Adeboye Fashina , Mustafe Abdillahi Omar , Ahmed Abdullahi Sheikh , Funke Folasade Fakunle	2021	Exploring the significant factors that influence delays in construction projects in Hargeisa	The results showed that the three main reasons for delays affecting construction projects in Hargeisa are (increased project/failure estimated cost of the project/failure to take approval for fundamental changes in the project promptly causing delay / gradual delay in payment). These findings are essential for future projects. Hence, more attention is paid to applying critical project management tools such as risk management in construction projects and good sourcing. Appropriate project management procedures should be used to control the 16 dangerous delay factors when undertaking future construction projects.
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Table 2.1: Results of the Literature Review Publications Addressed in This Work “Table Continued”

6	Essa Alenazi , Zulfikar Adamu and Ali Al-Otaibi	2022	Exploring the Nature and Impact of Client-Related Delays on Contemporary Saudi Construction Projects	The study showed eight main causes of client-related delay in values of CPI between 0.84 and 0.89, in addition to the SPI index with values ranging from 0.71 to 0.82, which indicates weakness in two main things, namely cost and time. The most crucial delay factor is the change order, the rest of the reasons are weak communication among the project parties and a delay in the payment process, as well as ineffective planning in projects, and there are other reasons, such as errors and differences in design, delay in approving the bill of quantities that have been modified and delay in starting projects. The last factor is the lack of funding from the client to complete the work.
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Table 2.1: Results of the Literature Review Publications Addressed in This Work “Table Continued”

7	Hayssam O. Elhusseiny , Ibrahim Nosair , A. Samer Ezeldin	2021	Developing a user plug-in to assess delay causes' impact on construction projects in Egypt	The results came that the program could analyze the cost and duration related to the reasons for the delay, and the percentages were determined. As for internal activities such as changes and placement of change orders during construction, the rate associated with delay claims was 15.1%. As for cost savings, it was 1.2%. As for the rest of the reasons for the delay, such as (the poor level of workers' production, the owner's delay in payment, and the lack of equipment needed for construction), the decline rates for late claims were 0.3% for the first, and 1.3% for the claims. The second reason, and 1.1% for the third reason, while the savings rates were 0.1% for the first reason and 0.3% for the second and third reasons. The external causes are out of control and difficult to control.
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Table 2.1: Results of The Literature Review Publications Addressed in This Work “Table Continued”

8	Aldana Abdulla Alsulaiti and Laoucine Kerbache	2020	Analysis of Critical Delay Factors in Construction Projects with a Focus on Qatar	The study showed that the changes are large for complex projects, while the delay is smaller for less complex projects. It confirmed that knowing the delay factors early in project management ensures good performance promptly. A framework was formed to compare performance for four categories of projects. It is determining three risk factors and knowing the weight of each element concerning the delay and how these things affect the scheduling. One of these factors is the delay due to inspection by the authorities and changes in the foundations of the project. This leads to two main results, namely, the strong influence of stakeholders on project performance and what happens from Changes and delays in the final critical stage corresponding to the delivery stage.
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Table 2.1: Results of the Literature Review Publications Addressed in This Work “Table Continued”

9	Serdar Durdyev and M. Reza Hosseini	2019	Causes of delays on construction projects: a comprehensive list	The results of this study showed the weakness of project schedules, and this leads to problems in projects in developing countries, which identified the reasons for impeding the plan, such as human resources, in addition to material causes, and this was confirmed by 20 documents that were examined, in addition to the fact that the problems arising from off-site manufacturing were observed in the research that had been studied.
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Table 2.1: Results of The Literature Review Publications Addressed in This Work “Table Continued”

10	Subhav Singh Anju Bala Saurav Dixit Deekshant Varshney	2018	Critical Analysis of Causes of Delay in Residential Construction Projects in India	The results showed the major reasons for project delays in India are poor procurement planning, lack of materials at the work site, frequent return of work, difficulty in accessing the site, change in weather conditions, inadequate equipment and scarcity of consultants and contractors. The RII analysis is between eight essential factors, how these factors relate to each other, and how these factors are directly responsible for the project delay. By adopting the RII method in factor analysis, the factors related to management are considered the most important, as they contribute 42% to the postponement of projects. Among the management-related factors are the delay in approving all executive plans, the lack of coordination between all teams, the delay in finalizing all items, and the lack of procurement planning.
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Table 2.1: Results of The Literature Review Publications Addressed in This Work “Table Continued”

11	Omar et al	2022	MitC: Open-source software for construction project control and delay mitigation.	It was confirmed the research concluded that the traditional possibilities of construction planning is overly inflexible in the number of needed mitigation factors that causes over-cost. The MiTC prevents selecting standard distributions in the Monte Carlo distribution. The program supposes unlimited employers and material references when choosing mitigation factors. Furthermore, it was proved that the adopted reward/penalty chart identifies the ideal date of achievement of the project.
12	Mohammad Nafe Assafi, Md. Mehrab Hossain, Nicholas Chileshe, Shuvo Dip Datta	2022	Development and validation of a framework for preventing and mitigating construction delay using 4D BIM platform in the Bangladeshi construction sector	The researchers found that when applying the suggested framework in the pre-start phase of the project, the possibility of errors was reduced by checking the model several times according to the framework. As for applying the framework to manage the delay in the implementation stage, which is the most difficult, they found that using the 4D Time Liner tool can help reveal the reason for the delay. Then the project manager must take the appropriate action to complete the construction process.

Table 2.1: Results of The Literature Review Publications Addressed in This Work “Table Continued”

13	Ahmad Sholichan, Albert Eddy Husin	2021	Optimization of M-PERT & BIM 5D to Minimize the Risk of Time Delay & Overrun in Stadium Project Structure Works: Key Success Factors	The researchers found that the most influential factors on the effectiveness of improving M-PERT and BIM 5D to reduce the risk of delaying time and increasing cost, especially the structural works of stadium projects, are: (a) Unrealistic scope, schedule and budget, (b) Simplification of the activity network, (c) Combination & merger of project, (d) High accuracy between planned and actual, (e) Structural Design Complexity, (f) 3D modelling details,7) Quantity Take-Off, (g) Detailed drawings and precise specifications, (h) Completeness of Bill of Quantity, and (i) Complicated installation techniques.
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Table 2.1: Results of The Literature Review Publications Addressed in This Work “Table Continued”

14	Muhamad Azry Khoiry, Suhaniya Kalaisilven, and Azlina Abdullah	2018	A Review of Minimizing Delay in Construction Industries	The result of the review came by categorizing the ideas of reducing delays based on essential elements in construction into four main criteria to reduce delays, which are: First: Management, including the concept of sound management promptly, control of the construction project, and financial management, and Second: Personality: as it deals between the parties Building good interpersonal relationships. The third is the technical matters based on correctly selecting skilled and competent labour. It includes the presence of a qualified contractor to conduct a project and a technician that guarantees the quality of the construction project, and fourthly, technology: following modern methods of tools and programs in construction, which increases the quality of construction, which affects productivity.
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Table 2.1: Results of The Literature Review Publications Addressed in This Work “Table Continued”

15	Jung Eun Park	2021	Schedule delays of major projects: what should we do about it?	The study recommends predicting the reference category to mitigate delay. Also, these practices are vital to deal with complex problems in schedule and cost estimation. Since the reference category forecasting implementation, cost overruns for UK transport projects show a difference compared to schedule delays. Average schedule delay decreased from 21% to 26%, and average cost overrun reduced from 38% to 5% in the UK, with the frequency of underestimation becoming statistically less frequent in cost estimates (46%) than in schedule estimates (77%) From UK projects.
16	Hayssam <i>et al</i>	2020	Systematic processing framework for analyzing the factors of construction projects' delays in Egypt.	The findings suggested a methodical methodology for analyzing delay troubles with building projects in Egypt while confirming findings through survey questionnaires. This method helped to prioritize delay reasons and contributed to determining the most appropriate methodology for handling structural project delays and their related cost influence. Moreover, this approach benefits construction structures like suburban buildings and hotels.

Table 2.1: Results of The Literature Review Publications Addressed in This Work “Table Continued”

17	Muiz et al	2020	Machine learning model for delay risk assessment in tall building projects	It was affirmed that the model improved in this research can efficiently supply hazard-based decision taking in long structure projects. Even though the model relies on data from long-structure experts in the GCC area, the methodology utilized can be suited to other global climates.
18	Prasad K.V. and Vasugi V. Venkatesan R. Nikhil Bhat	2019	Analysis of causes of delay in Indian construction projects and mitigation measures	The results indicated some reasons for the delay in Indian projects. The most vital one was related to the financing of projects. Also, the reasons for the disputes were the owner and the payment delays when there was additional work and making changes/during the construction process by the owner. Moreover, making a change in the design process is one of the reasons for the delay. From the comparison between the reasons for the delay in DB and DBB methods, researchers found significant differences using the two approaches.

Table 2.1: Results of The Literature Review Publications Addressed in This Work “Table Continued”

19	Ahmed <i>et al</i>	2019	Machine learning algorithms for construction projects delay risk prediction.	It was concluded that the naïve Bayesian scheme gives a better foretelling achievement for the set of data checked. Moreover, the work presented employs the energy of ML to simplify taking decision operations dependent on proofs. At the same time, hazard factors are energetic, linkage, and dynamic, which confirms proactive project hazard management methodologies.
20	Kajal <i>et al</i>	2017	A hybrid MCDM technique for risk management in construction projects	The results showed the estimate of a real world application of D-ANP-MABAC methodology. Also, the sensitivity results identified its possibility to supply stable solutions in case of difficult conditions. The suggested hazard methodologies alternatives are successfully classified. Thus, it was revealed that the previous approach has provided an alternate methodology for sustainable hazard analysis and deciding in the construction field. Their proposed method considers both CFPR and ANP methodologies in the D numbers range.

2.5 CHAPTER SUMMARY

Contractors must be obligated to implement projects thoughtfully within the time limits specified for them, avoid delays resulting from delay, try to complete the project as quickly as possible and avoid delays in its delivery, and try to reduce costs through managing Successful projects within the specified time. Through a theoretical review of the previous literature, the primary causes of building project delays were determined, and the reasons differed from state to state due to the different environments of the construction industry and other surrounding reasons. All studies confirmed that to manage the project properly for external reasons.

The best way to avoid the delay causes and mitigate its impact is to know its reasons early. Also, it is essential to discuss these factors' impact and identify each element's effect separately. Moreover, it is vital to use modern cost and schedule management technologies, such as BIM.

3. RESEARCH METHODOLOGY

3.1 INTRODUCTION

This chapter presents the methodology used to answer research questions during this study. The following topics are discussed: research design, selection of participants and research sample, validation and reliability of tools, methods used during data collection, and explanations on how to analyse data. This chapter's statistical investigation seeks to ascertain: The order and relative weights of the critical factors that affect losses resulting from exceeding the specified time for completion and its impact on the project status and delay in utilizing services. The questionnaire will be selected in the data analysis process based on a set of questions related to losses resulting from exceeding the specified time for completion and its impact on the status of the project and delay in utilizing services.

3.2 RESEARCH DESIGN

Research design is the conceptual framework that underlies the conduct of research and includes collecting and analysing relevant data. The plan explains the investigative approach chosen to obtain reliable and valid data to achieve the research objectives and answer the research questions.

This study relied on mixed approaches in research design to choose research procedures, and to ensure that the methodology used is compatible with the study's objectives and the research problem using quantitative and qualitative approaches. The survey was used to collect data for the quantitative part of this study. A quantitative approach enables researchers to collect large-scale data and compare the relationship between all the variables used. This study used quantitative and qualitative surveys and interview questions to collect data. A questionnaire was designed and distributed to experienced people to investigate the factors that affect losses resulting from exceeding the specified time for completion and its impact on the project status and delay in utilizing services [86], [87].

3.3 RESEARCH APPROACH

The research approach is considered a way of thinking that the researcher uses to infer the research design method. The research approach contains three basic types that include qualitative, quantitative, and mixed, as the data analysis process is based on three forms, which are inductive, deductive, and combined.

This research uses a mixed qualitative and quantitative approach, where the qualitative approach is based on the researcher's impression by evaluating opinions and behaviours. In contrast, the quantitative approach is based on quantitative data collection for data analysis.

In the qualitative approach method, the researcher answers research questions by addressing the problem descriptively by conducting interviews, while in the quantitative approach method is based on clear and explicit facts that can be proven true through empirical hypotheses. In contrast, the quantitative approach uses the quantitative survey to collect and analyse data.

3.3.1 Quantitative Research

Quantitative research depends on collecting numerical data that are analysed through statistical methods to ensure accurate, reliable, measurable data that can be distributed over a large population [86]. A quantitative research approach was used to collect data by designing a questionnaire that includes all the data to be analysed on several respondents, based on the Five Likert scales. Given that the researcher can effectively communicate the quantitative approach to a large number of respondents, it is one of the preferred techniques for data collecting and analysis. In other words, quantitative research provides answers to the study questions with further explanation and interpretation based on graphs, statistics, numbers, and numerical results of the investigation [86], [88].

3.3.2 Qualitative Research

Qualitative research uses a method to provide the researcher with the appropriate way to understand the research problem through observation and interaction with the study participants, as it relies on data collection and analysis of the results of data collection based

on behaviours and concepts [88]. In this research, the researcher used quantitative and qualitative approaches by using the Five Likert scale.

3.3.3 Mixed Research

Mixed research depends on the analysis and collection of quantitative and qualitative data, as it is based on the principle of data integration in one or more stages in the research process. The mixed approach enables the researcher to answer the study questions that cannot be answered through qualitative and quantitative methods. Figure 3.1 shows the steps involved in the research stages.

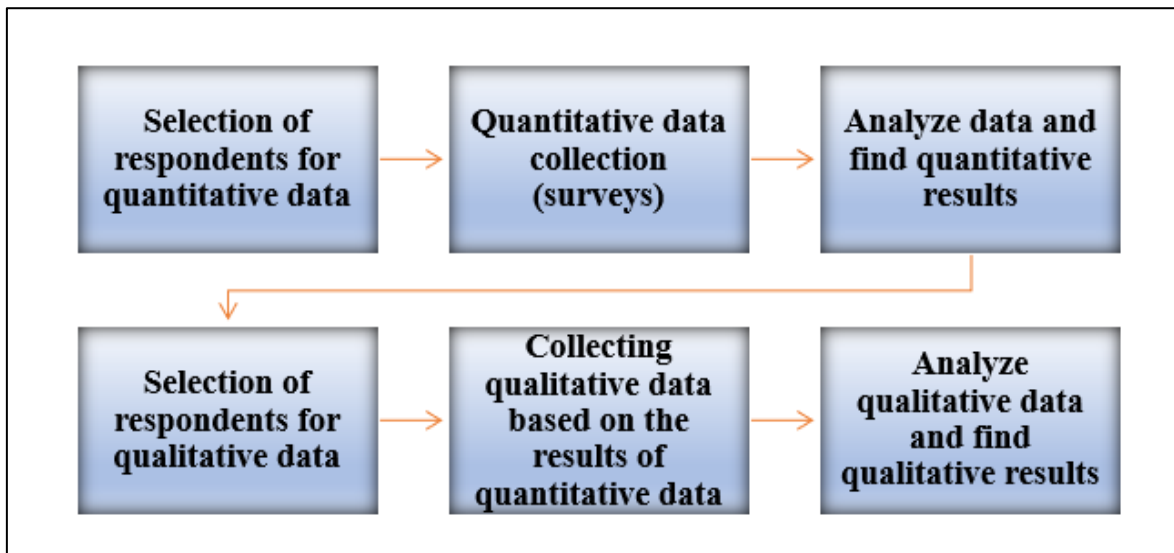


Figure 3.1: The Major Mixed Methods Used in The Research.

3.4 POPULATION

Project managers, engineers, and contractors who operate in Iraq's construction industry are the study's target demographic. Respondents were requested to complete the offered questionnaires in order to participate in the research survey. The study sample was selected with experience and expertise to obtain more accurate and reliable information about the study. Figure 3.2 indicates the sampling design process.

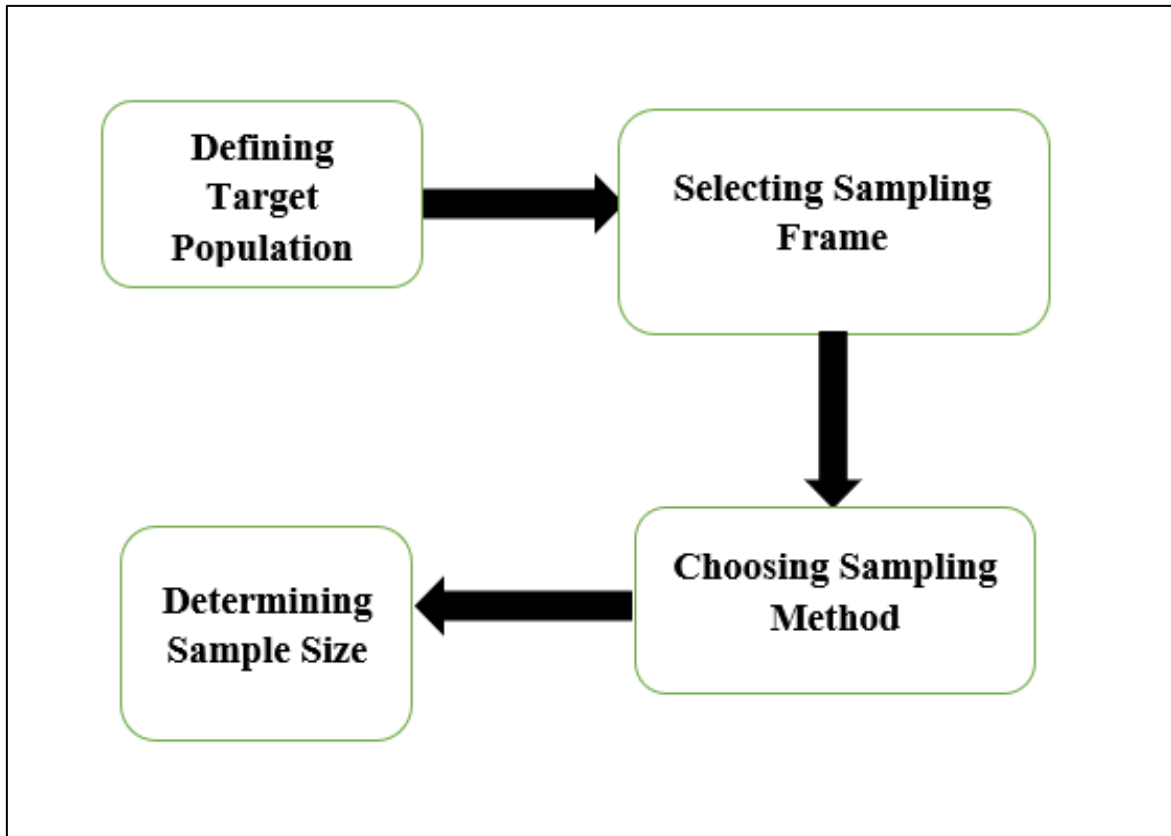


Figure 3.2: The Sampling Design Process.

3.5 SAMPLE SIZE

The quantitative approach utilized in research design uses sampling strategies that are generally well recognized and founded in probability theory. The sampling techniques used in the qualitative approach, however, are frequently less obvious.

The sample size selection stage is one of the important stages due to its importance in saving cost, time, and effort. Usually, the sample size is limited by the time specified for taking the respondents' answers to the study questions during the data collection process, as data collection in the qualitative research approach takes a long time. In this study, the research sample consists of 100 respondents. The Stephen Thomson equation was applied to calculate a statistically representative population sample [89], [90].

$$n = \frac{N \times p \times (1 - p)}{(N - 1) \times \frac{d^2}{Z^2} + p \times (1 - p)} \quad (3.1)$$

Where:

n : The size of the sample

p : The proportion of the population

Z : The standard score corresponding to the significance level. (1.96)

d : The standard error related to the sampling distribution. (0.05)

N : The size of the population

If the p-value is unspecified [90], the recommended (p) value is 0.5, and a large number of samples is obtained as necessary. The researcher employed a confidence level of 95% and a level of significance of 5% in this investigation.

The sample size of the population was calculated as follows:

$$n = \frac{100 \times 0.5 \times (1 - 0.5)}{(100 - 1) \times \frac{0.05^2}{1.96^2} + 0.5 \times (1 - 0.5)} \approx 79 \quad (3.2)$$

Project managers, engineers, and contractors employed in Iraq's construction industry make up the population (N), with N equals 100.

3.6 QUESTIONNAIRE DESIGN

The questionnaire was created as a survey tool and to produce accurate findings. The main objective of the questionnaire is to determine the factors that influence the losses resulting from exceeding the specified time for completion and its impact on the status of the project and delay in utilizing services, the results of which were evaluated at the level of Five Likert.

Many sources, including earlier research and studies, were cited in the questionnaire, also to distributing an open questionnaire to several project managers, engineers and contractors working in the construction sector in Iraq to determine the factors that affect the losses resulting from exceeding the specified time for completion and its impact on the status of the project and delay in utilizing services. Figure 3.3 shows the questionnaire design steps.

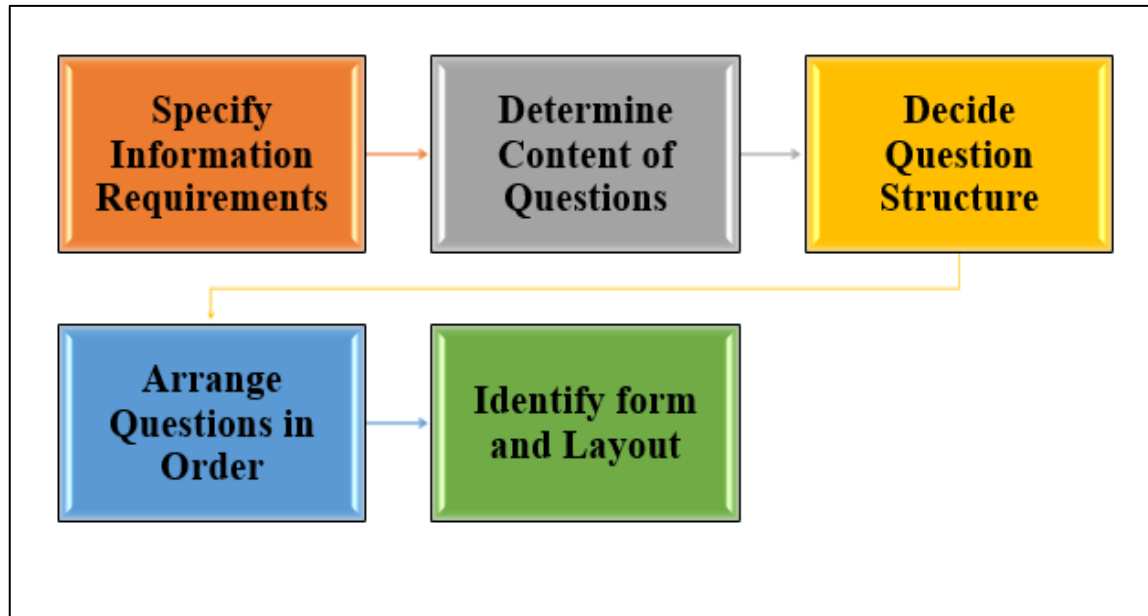


Figure 3.3: Questionnaire Design Steps.

The questionnaire is examined for these three essential components:

a. Validity

If an instrument accurately measures the thing it is intended to measure, it is considered legitimate. When a questionnaire is presented to a specialized committee for an in-depth examination of the content and questionnaire components, the reliability of the survey is determined by the degree of inaccuracy in the components and form of the questionnaire [91]. The instruments needed for research must be identified before data collection. The questionnaire was presented to a committee of specialized experts to evaluate the quality of the questionnaire and verify its credibility before analysing the data.

b. Reliability

Reliability contributes to maintaining the stability of the questionnaire that will be analyzed based on the results of the target sample. When choosing a questionnaire, the reliability tool must be considered because it greatly affects the quality of the data used in the questionnaire analysis. The process of calculating the reliability of the questionnaire is done by calculating Cronbach's alpha coefficient. When noticing any deviation from the respondents, the reliability of the questionnaire should be reduced to give results within the required and acceptable range.

c. Content Validity

Weaknesses in the questionnaire are identified by presenting it to a committee of experts in the field on which the questionnaire is based, by not addressing those points based on the instructions and directives of the specialized committee. Therefore, this step is considered extremely important for its role in measuring the validity of the content and determining the clarity and accuracy of the questionnaire questions.

3.7 RESEARCH METHODOLOGY

This study uses the survey to determine the factors that affect construction. The research methodology is designed with clear steps to reach the desired study objectives by answering the questionnaire questions accurately. The research methodology depends on investigating quantitative and qualitative research methods based on induction and deduction methods. The strategy used from experiments and surveys is interpreted, and then the data collection and analysis of the results is obtained through observation, interviews, and a questionnaire. This study relied on the use of a survey by designing a questionnaire using a Five Likert scale to convert qualitative data into quantitative data. Figure 3.4 shows the research methodology used.

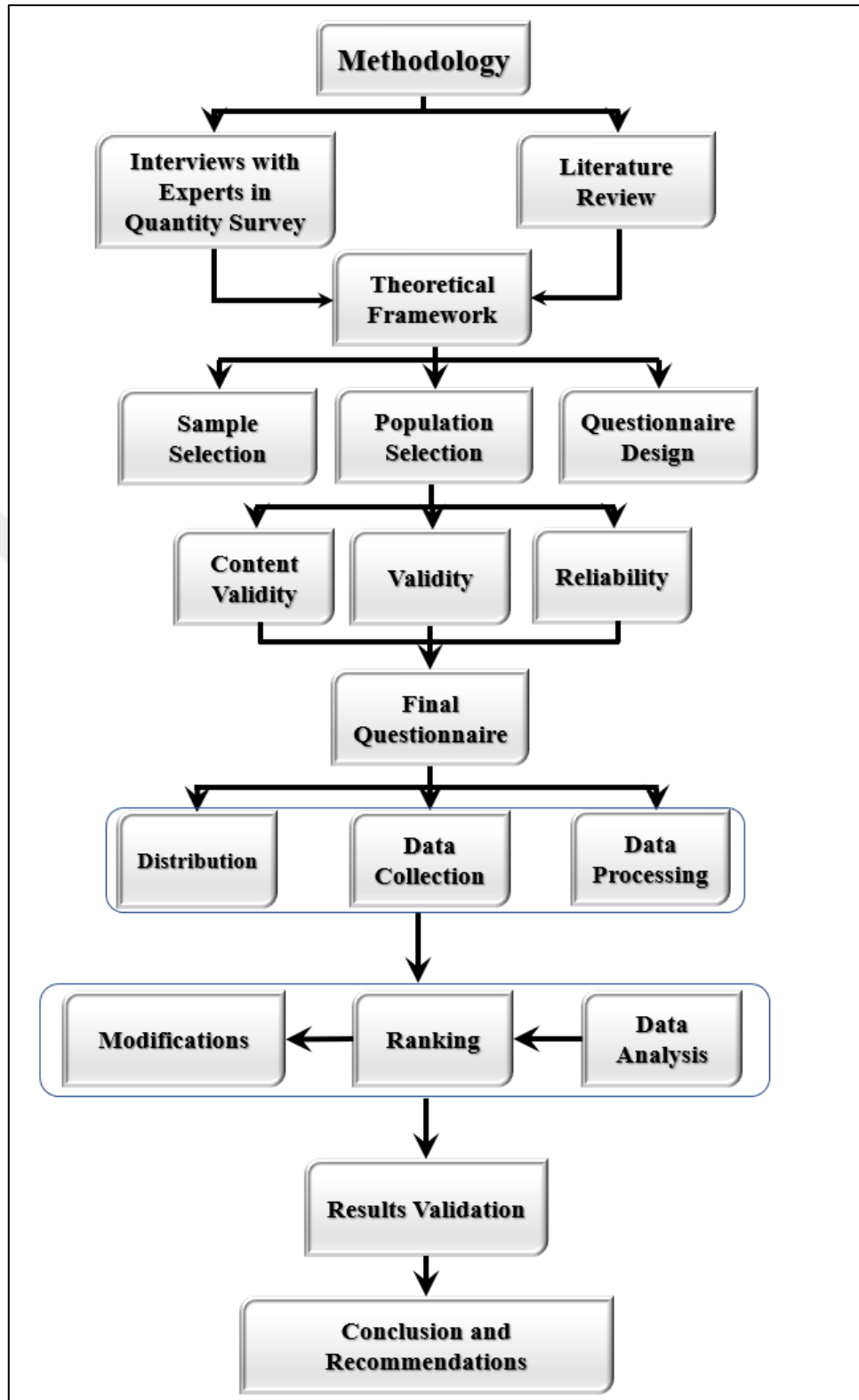


Figure 3.4: The Methodology of This Work.

3.8 DATA COLLECTION

The researcher used both primary as well as secondary data gathering methods to complete the study to obtain in-depth and accurate information about the building, as the primary data is information collected to achieve the study's objectives through the interview and questionnaire. Quantitative and qualitative data were collected. Figure 3.5 shows the procedures for collecting search data.

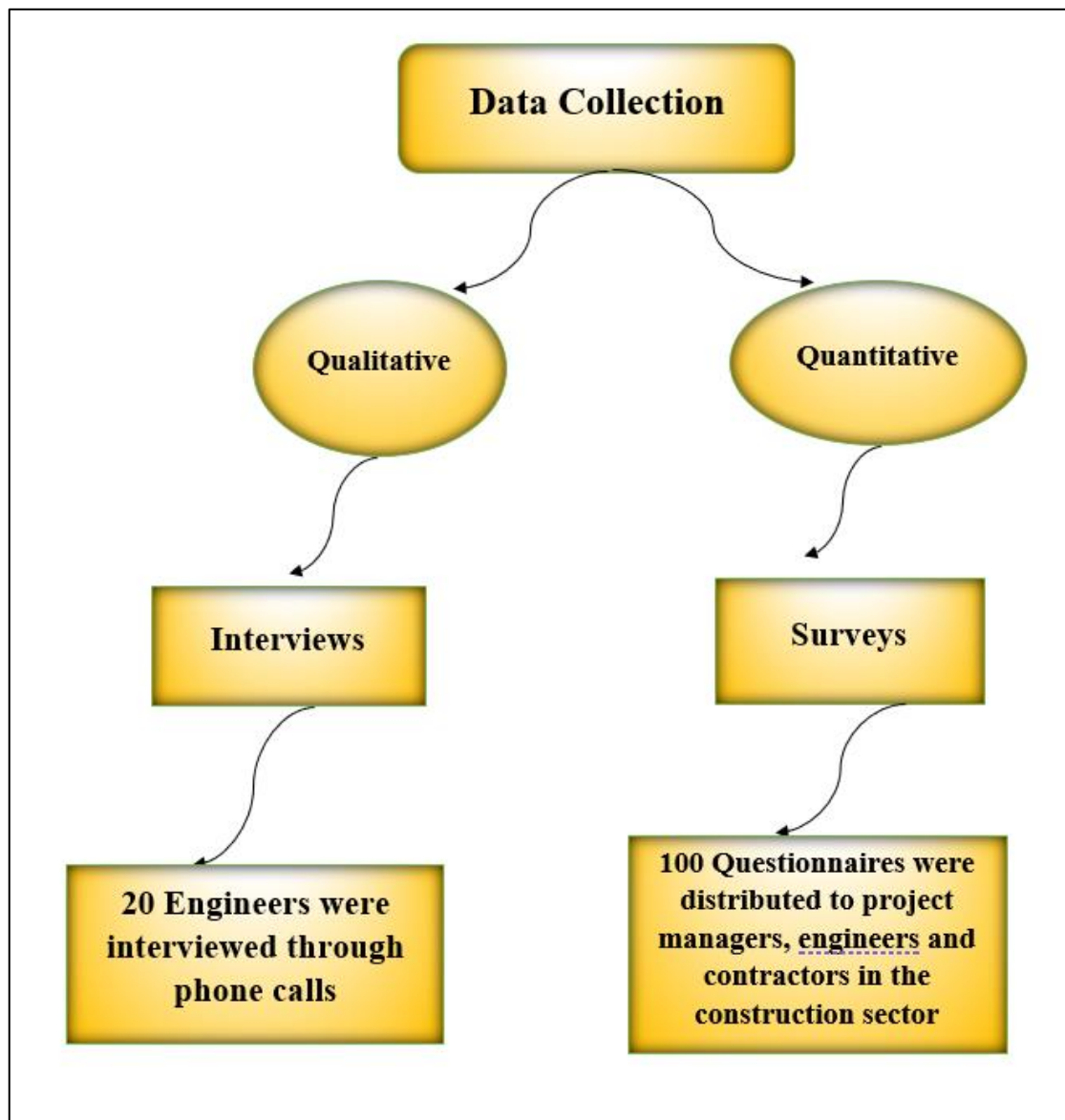


Figure 3.5: Data Collection Procedures.

a. Interview: information is collected through oral or verbal communication between the researcher and respondents.

b. Questionnaires: The questionnaire is designed for the scheduled interview and is self-administered with open and closed questions for project managers, engineers, and contractors. The purpose of the questionnaire was to determine the factors affecting the construction, as the questionnaire emphasized the achievement of the research objectives and answered the research questions.

3.9 MEASUREMENT DEVELOPMENT

Given the variety of measuring scales available, including the following, the measuring scale was created to be employed to assess the importance and worth of variables:

- i. Ratio scale: Because it depicts the number and equality of units, this scale is the same as the Interval scale. But there is also an absolute zero on this scale (i.e., there is no number lower than zero).
- ii. Interval scale: It serves as a means of measuring and contains equal units; also, because it is an interval scale, 0 is just another measurement point.
- iii. Nominal Scale: Measurement of categorical numbers and data that appear as identifiers and names is done using the nominal scale.
- iv. Ordinal scale: This type displays relationships in an organized, precise order.

In order to measure the scores and the level of significance for this study, integers for ordinal scale, the Likert scale, and the ordinal scale were all used [91].

$$\text{Statistically Significant Levels} = \frac{\text{Max value} - \text{Min.value}}{\text{Max.value}} \quad (3.3)$$

Statistical significance levels, *SSL*, equals:

$$SSL = \frac{5-1}{5} = 0.8 \quad (3.4)$$

Table 3.1 displays the significance levels that are employed in this research.

Table 3.1: The Significance Levels That are Employed in This Research.

Level	Interval of Mean	Description
1	1.00-1.80	Very High
2	1.81-2.60	High
3	2.61-3.40	Medium
4	3.41-4.20	Few
5	4.21-5.00	Very Few

3.10 STATISTICAL ANALYSIS

The SPSS program analyzes the data when the process of gathering the questionnaire-related information is complete in order to generate the measures, as indicated in Table 3.2.

Table 3.2: Statistical Measures.

The Measure	The Description
Sample Normal Distribution Test	In order to ensure that the survey responses are of the highest possible quality, this test is employed to contrast the average of a group of measures with a certain constant.

Table 3.2: Statistical Measures. “Table Continued”

Arithmetic Mean	Only quantitative data is used on this scale, and anomalies can alter it.
Coefficient of Cronbach's Alpha	By comparing each axis to the average of all the axes in the questionnaire and also based on demonstrating the connection between the average correlation and number of test items between all items, this scale can be used to evaluate various values associated with internal consistency. The Cronbach's coefficient ranges from zero to one; the closer it is to one, the more stable the relationship; the nearer it is to zero, the less stable the relationship.
Impact Score	Standard deviation and the mean score are related to this scale.
Ranking	The average score is correlated with this scale.
Standard Deviation	It measures the degree to which responses deviate from the mathematical mean and is the positive square root of variance.
Frequency and Percentage.	They are used to predict the rate at which the participants confirmed on certain articles.

3.10.1 Chi-Square Test

A statistical analysis of hypotheses and sample distribution is done using the Chi-square test. It is employed to load fictitious data. A nominal scale must be used to categorize and measure variables. Additionally, it works to process qualitative data as iterations of certain groups

and to rebalance the frequency distributions of variables. The following features of this test set it apart, and they are depicted in Figure 3.6.

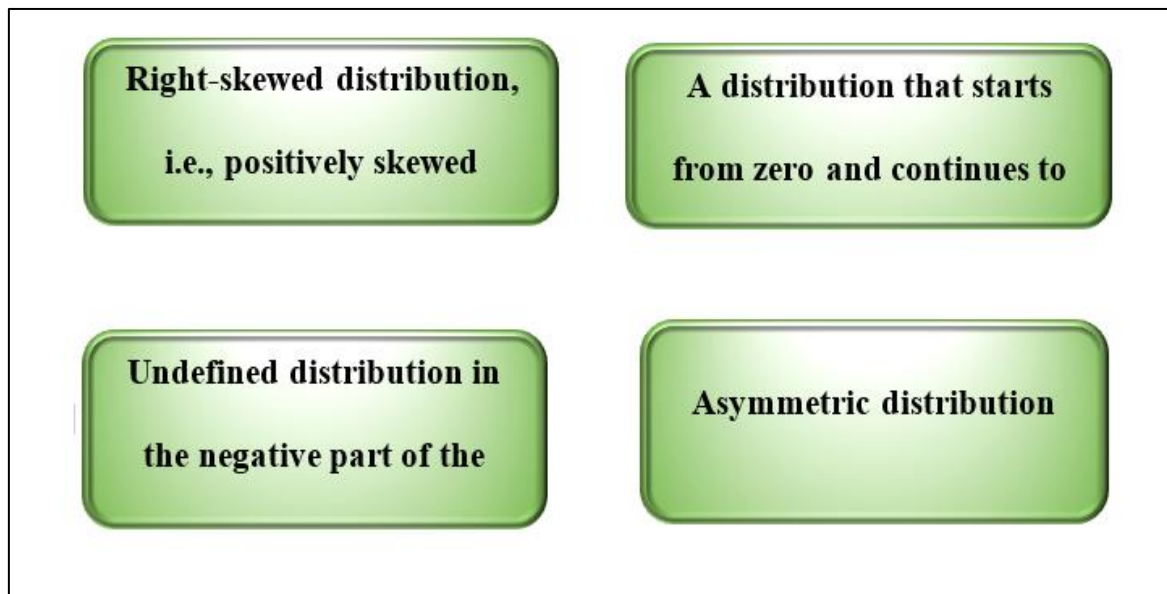


Figure 3.6: Chi-Square Testing Procedure.

3.10.2 Regression Coefficient Test

A statistical test called the regression test uses the significance of another variable to forecast the potential value of one variable. The regression test evaluates the direction of the correlation graphically and statistically, as well as the form and type of the correlation between two variables (the regression line).

Table 3.3: Types of Regression Tests.

Types of Regression	The Description
Non-Linear Regression	The dependent variable (y) and independent variables (x) have a nonlinear relationship by nature.
Multiple Regression	More than single independent variable influences the variable (R).
Simple Linear Regression	The connection between both variables (x, y) is linear in nature, with the dependent variable (y) depending on the one independent variable (x).

3.10.3 Correlation Coefficient Test

The correlation test is focused on figuring out how strongly two variables with values between are related to one another (1, -1). It has two variables (x, y), x is selected by the scientist conducting the study and is referred to as the independent variable, and y is referred to as the dependent variable. Because the outcome of this variable is uncertain and is dependent on the values of the independent variable, it is conditional (x).

Table 3.4: Correlation Types.

Correlation Types	The Description
Negative Correlation	The connection between two variables (X, Y), in which if one of the variables changes, the other will follow it in the opposite way.
Positive Correlation	The relationship (X, Y) between two variables in which, if one of the variables changes, the other one will do the same.

3.10.4 Z-Distribution Test

As illustrated in Figure 3.7, the normal distribution is employed to test hypotheses. Its value is calculated for each questionnaire question and varies between (-1.96 and 1.96) at the 95% confidence level.

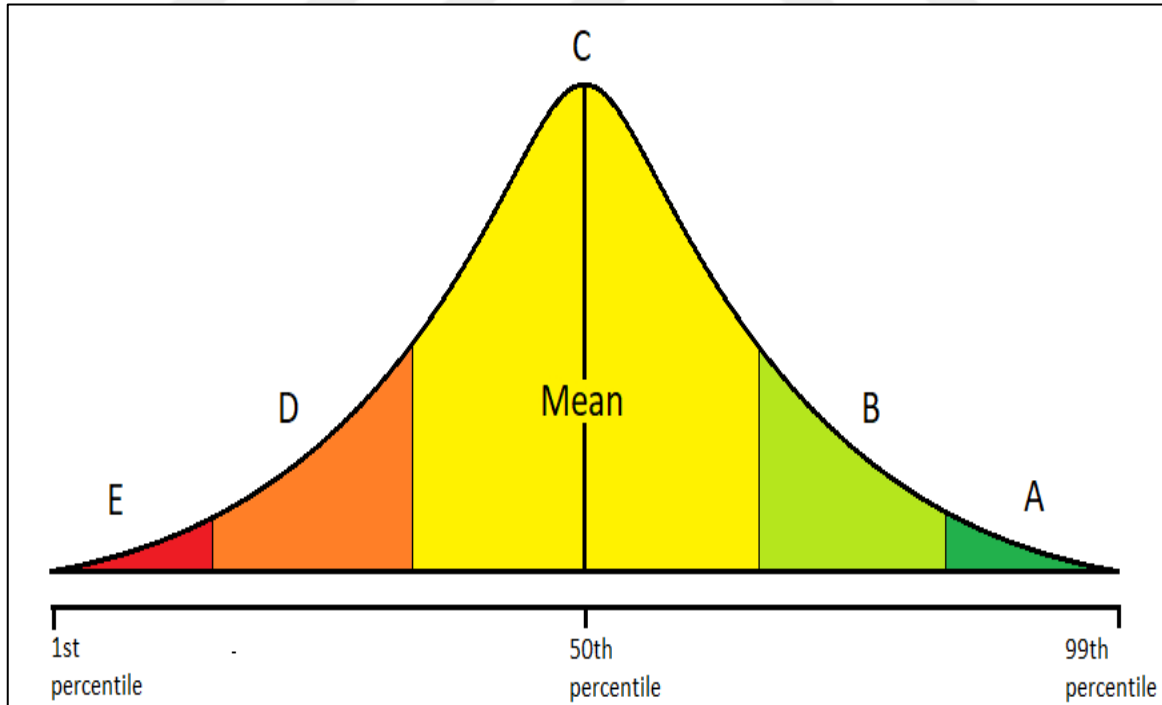


Figure 3.7: An Illustration of Normal Distribution [92].

Based on the following equation, numerous hypotheses are statistically investigated [93], [94]:

$$\text{Test value} = \frac{\text{observed value} - \text{expected value}}{\text{standard error}} \quad (3.5)$$

Where:

Standard Error : The error which is being tested.

Expected Value : If the null hypothesis were true, the parameter (population mean) that would be expected to be (hypothesized value)

Observed Value : From the sample data, the statistic (sample mean) is calculated.

The Z-test defined as following formula:

$$Z \text{ calculated} = \frac{X - \mu}{s/\sqrt{Nr}} \quad (3.6)$$

Where:

Nr : The overall number of answers for that choice or factor

S : The standard deviation

μ : The hypothesized population mean

X : The mean score

This formula is used to determine the value of (Zc) and compare it to the Z tabulated value. Finding Zc using this formula and comparing it to Z yielded the values (Zt = 1.96) and (Zt = -1.96), respectively. As a result, accepting or rejecting the questionnaire's values is simple.

3.10.5 Mean Score Ranking

The average score, which is calculated for each element using the point scale, is used to estimate the impact of each item on the same scale once the data from the questionnaire have been analyzed. The components are then put in descending order according to middle class. The following equation calculates the average arithmetic value [94]:

$$Ms = \frac{\sum_{xi=1}^n fi * xi}{\sum_{xi=1}^n xi} \quad (3.7)$$

Where:

f_i : The frequency

Ms : The mean score ($1 \leq Ms \leq 5$)

x_i : The degree of the criterion importance

3.10.6 Standard Deviation

When the data points are relatively close to the arithmetic mean, the dispersion around the arithmetic means is calculated so that the standard deviation is low. If the data points are dispersed at a greater level of values in which the standard deviation is large, the anticipated value is called. The following equation is used to compute the standard deviation value [93]:

$$S = \sqrt{\frac{\sum_{k=0}^n (xi - x)^2 * fi}{n - 1}} \quad (3.8)$$

Where:

S : The standard deviation

N : The Number of samples

X : The mean score

3.10.7 Cronbach's Coefficient Alpha

It is used to gauge a test's level of dependability by measuring internal consistency. The mean questionnaire axes, the correlation between both the number of test items, and the moderate correlations between these items are all compared to each axis.

The Cronbach's alpha coefficient value is calculated by the following equation [95]:

$$\alpha = \frac{N_{it} \times C}{V + (N_{it} - 1) \times C} \quad (3.9)$$

Where:

V : The average variance of all items

C : The average inter-item variance between items

N_{it} : The number of items

The permitted value range must be (0.0 & +1.0). If Cronbach's alpha is less than this threshold, it will not be approved because a greater number will indicate a higher level of acceptable internal consistency.

The Cronbach coefficient rises as the number of components and mean correlation between the variables rise. Otherwise, the alpha of the Cronbach coefficient will be high if the moderate correlation between the elements is low.

4. RESULTS AND DISCUSSION

4.1 INTRODUCTION

In this chapter, the study's results are presented and discussed with reference to the study's objective, which is to determine the effect of losses resulting from exceeding the specified time for completion and its impact on the status of the project and delay in utilizing services. The research steps were described in the previous chapter, which presented the methodology used in the study.

To improve the method' accuracy and dependability, respondents were carefully chosen. Participants have worked on civil engineering and building projects.

4.2 DEMOGRAPHIC CHARACTERISTICS

This section gathered information on the makeup of knowledgeable respondents in terms of academic, gender, general specialty, construction industry experience, category, project job, and position. Table 4.1 indicates gender of the respondents.

Table 4.1: Gender of the Respondents.

Variable	Category	Frequency	Percentage (%)
Gender	Male	81	79.4
	Female	19	18.6

Table 4.2 illustrates further information on the SPSS analysis of gender.

Table 4.2: Further Information on The SPSS Analysis of Gender.

<i>Gender</i>					
Classification		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Male	81	79.4	81.0	81.0
	Female	19	18.6	19.0	100.0
	Total	100	98.0	100.0	
Missing	System	2	2.0		
Total		102	100.0		

Table 4.2 shows the frequency and gender ratio of all respondents. Males got the most significant percentage with 79.4%, while females got 18.6% (see Figure 4.1).

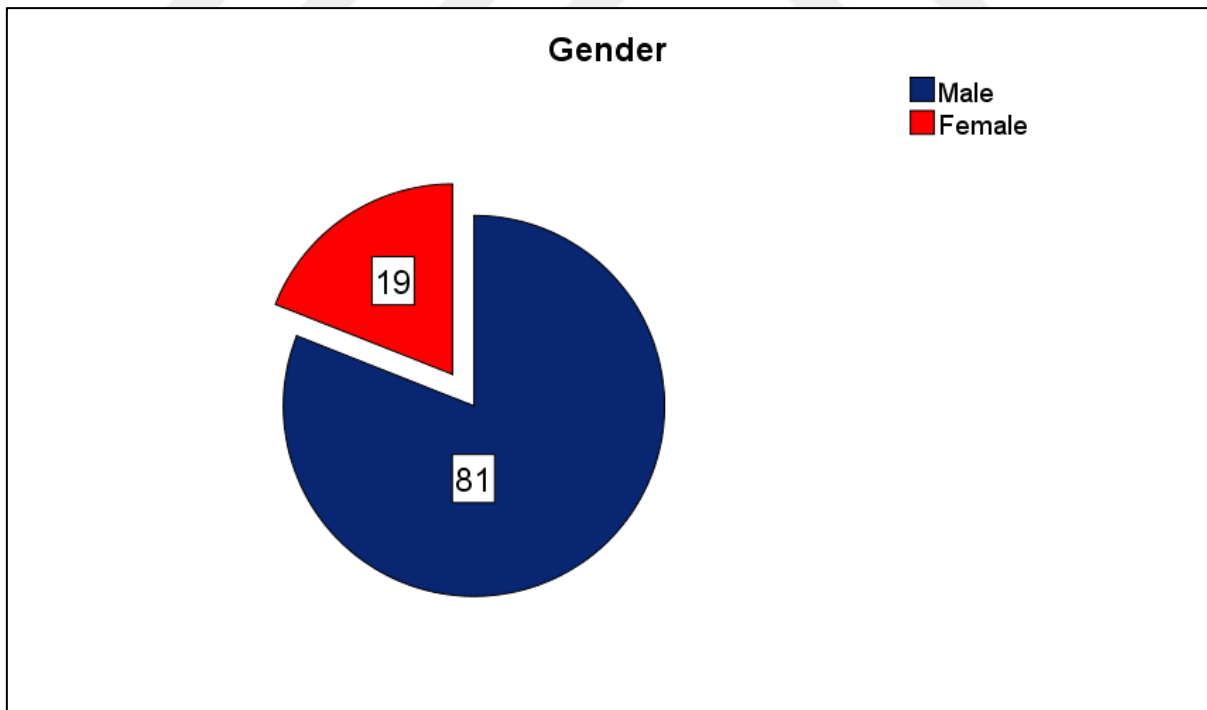


Figure 4.1: Graphical Representation of Respondents' Demographic Data Linked to Gender.

Table 4.3 shows the academic level of the respondents.

Table 4.3: Academic Level of the Respondents.

Variable	Category	Frequency	Percentage (%)
Academic	Bachelor's	25	24.5
	Diploma	3	2.9
	Master's	70	68.6
	PhD	2	2.0

Table 4.4 illustrates further information on the SPSS analysis of academic level.

Table 4.4: Further Information on The SPSS Analysis of Academic Level.

Academic Level					
Classification		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Bachelor's	25	24.5	25.0	25.0
	Diploma	3	2.9	3.0	28.0
	Master's	70	68.6	70.0	98.0
	PhD	2.00	2.00	2.00	100
	Total	100	98.0	100	
Missing	System	2	2.0		
Total		102	100		

Respondents of different academic degrees (Bachelor's, Diploma, Master's, and PhD) were represented in more significant numbers in master's and bachelor's degrees, representing 70 (68.6%) and 25 (24.5%) of respondents, respectively. Figure 4.2 illustrates these results.

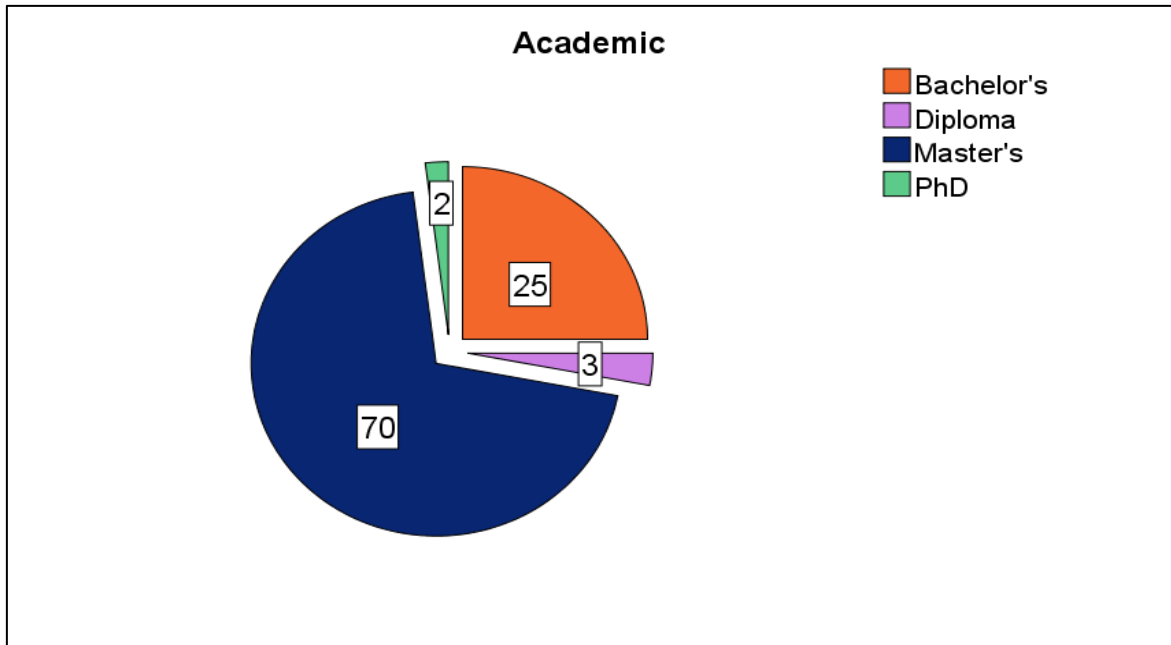


Figure 4.2: Graphical Representation of Respondents' Demographic Data Linked to Academic Level.

Table 4.5 describes general specialty of the respondents.

Table 4.5: General Specialty of the Respondents.

Variable	Category	Frequency	Percentage (%)
General Specialty	Civil Engineering	67	65.7
	Architectural Engineering	20	19.6
	Electrical Engineering	9	8.8
	Mechanical Engineering	4	3.9

Table 4.6 illustrates further information on the SPSS analysis of general specialty.

Table 4.6: Further Information on The SPSS Analysis of General Specialty.

<i>General Specialty</i>					
Classification		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Civil Engineering	67	65.7	67.0	67.0
	Architectural Engineering	20	19.6	20.0	87.0
	Electrical Engineering	9	8.8	9.0	96.0
	Mechanical Engineering	4	3.9	4.0	100.0
	Total	100	98.0	100.0	
Missing	System	2	2.0		
Total		102	100.0		

The results of this study showed that most respondents held the majors of civil engineering and architecture, 67 (65.7%) and 20 (19.6%), respectively. Figure 4.3 illustrates these results.

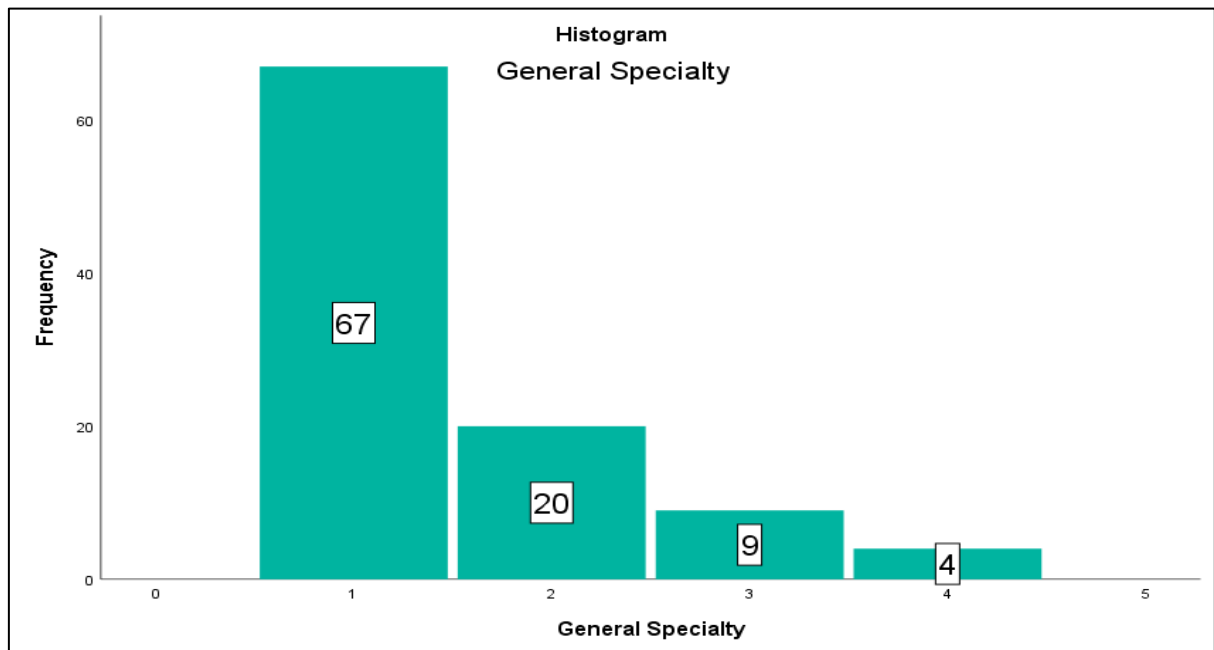


Figure 4.3: Graphical Representation of Respondents' Demographic Data Linked to General Specialty.

Table 4.7 describes experience in construction industry of the respondents.

Table 4.7: Experience in Construction Industry of The Respondents.

Variable	Category	Frequency	Percentage (%)
Experience in Construction Industry	0-5 years	9	8.8
	5-10 years	13	12.7
	10-15 years	68	66.7
	15-20 years	7	6.9
	20 and above	3	2.9

Table 4.8 illustrates further information on the SPSS analysis of experience in construction industry.

Table 4.8: Further Information on The SPSS Analysis of Experience in Construction Industry.

<i>Experience in Construction Industry</i>					
Classification		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0-5 years	9	8.8	9.0	9.0
	5-10 years	13	12.7	13.0	22.0
	10-15 years	68	66.7	68.0	90.0
	15-20 years	7	6.9	7.0	97.0
	20 and above	3	2.9	3.0	100.0
	Total	100	98	100	
Missing	System	2	2.0		
Total		102	100		

Table 4.8 shows the respondents' percentage and frequency of years of experience. The most considerable portion of respondents whose years of experience ranged from (10 to 15) years reached 66.7%, followed by experience years from category (5-10) years which amounted to 12.7%. (See Figure 4.4).

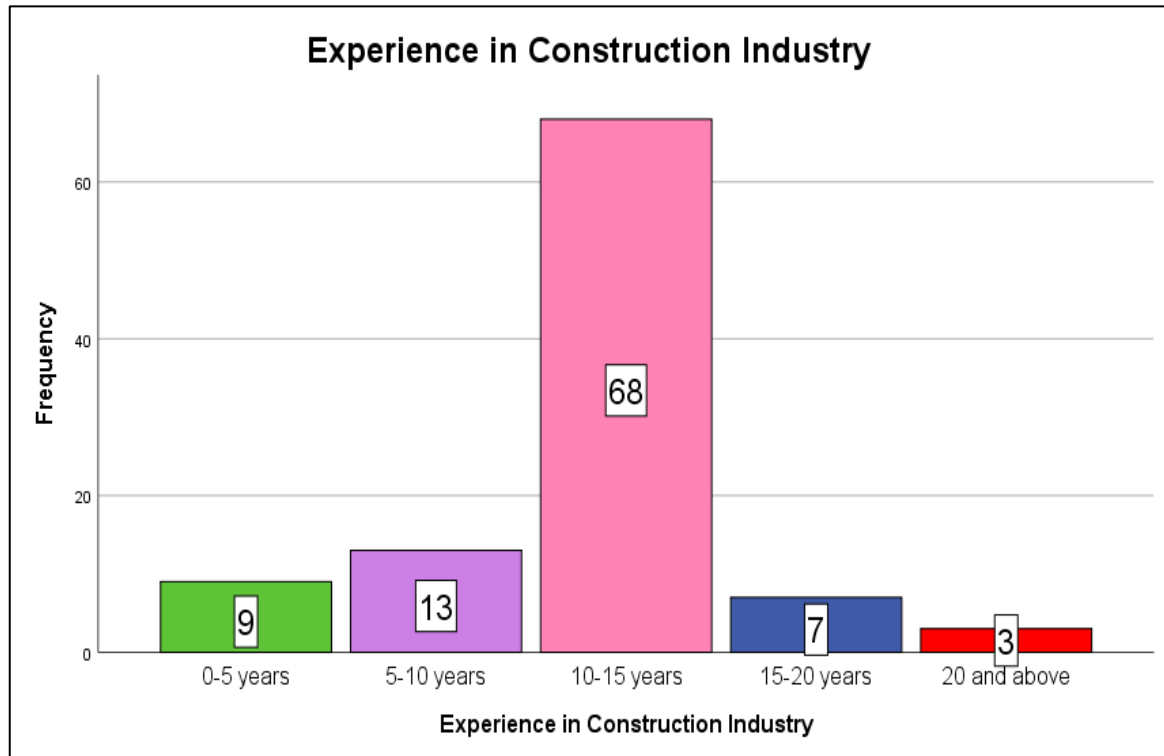


Figure 4.4: Graphical Representation of Respondents' Demographic Data Linked to Experience in Construction Industry.

Table 4.9 illustrates type of construction company of the respondents.

Table 4.9: Type of Construction Company of the Respondents.

Variable	Type of Construction Company	Frequency	Percentage (%)
Category	Public	31	30.4
	Private	69	67.6

Table 4.10 describes further information on the SPSS analysis of type of construction company.

Table 4.10: Further Information on The SPSS Analysis of Type of Construction Company.

<i>Category</i>					
Classification		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Public	31.0	30.4	31	31
	Private	69.0	67.6	69	100
	Total	100.0	98.0	100	
Missing	System	2	2.0		
Total		102	100.0		

The number of study samples was 100 respondents. The study was analyzed in the public and private sectors. A more significant proportion of respondents working in the private sector, 69 (67.6%), fell into this category compared to those working in the public sector, 31 (30.4%). Figure 4.5 shows the numbers for each sector.

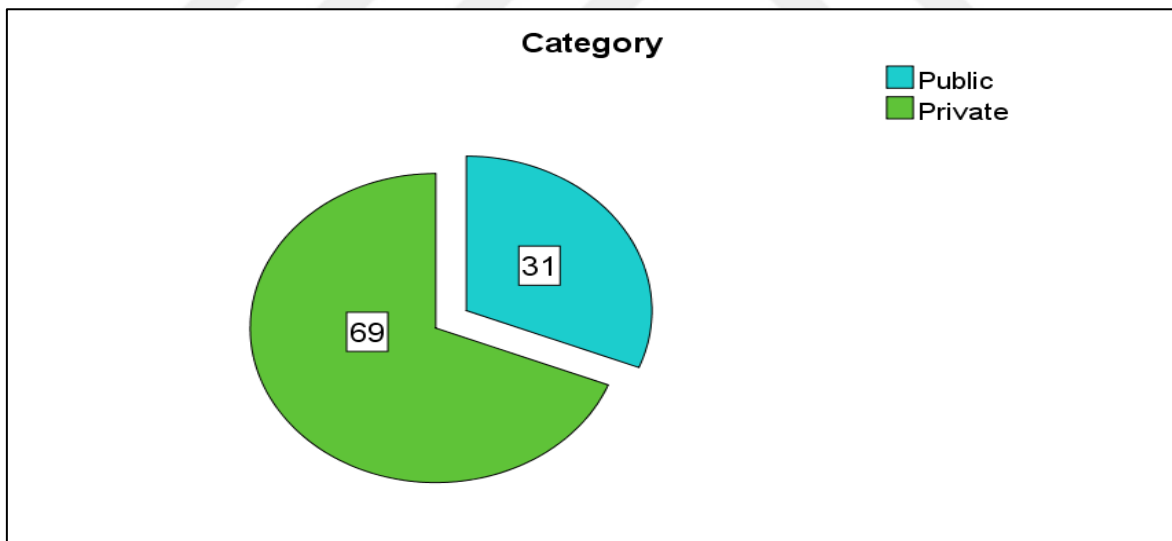


Figure 4.5: Graphical Representation of Respondents' Demographic Data Linked to Type of Construction Company.

Table 4.11 presents type of the job of the respondents.

Table 4.11: Type of the Job of the Respondents.

Variable	Category	Frequency	Percentage (%)
The Job in the Project	Investor	2	2.0
	Contractor	6	5.9
	Engineer (consultant, site, supervisor, etc.)	58	56.9
	Subcontractor	24	23.5
	Designer	10	9.8

Table 4.12 presents further information on the SPSS analysis of type of the job.

Table 4.12: Further Information on The SPSS Analysis of Type of The Job.

<i>The Job in the Project</i>					
Classification		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Investor	2	2.0	2.0	2.0
	Contractor	6	5.9	6.0	8.0
	Engineer (consultant, site, supervisor, etc.)	58	56.9	58.0	66.0
	subcontractor	24	23.5	24.0	90.0
	Designer	10	9.8	10.0	100.0
	Total	100	98.0	100.0	
Missing	System	2	2.0		
Total		102	100.0		

The study sample was distributed to the various jobs in the construction projects of (investor, contractor, engineer (consultant, site, supervisor, etc.), subcontractor, and designer. Figure 4.6 shows the distribution of jobs in the project. The highest percentage of respondents working in the field of engineering (consultant, site, supervisor, etc.) is 56.9%, followed by the subcontractor job at 23.5%.

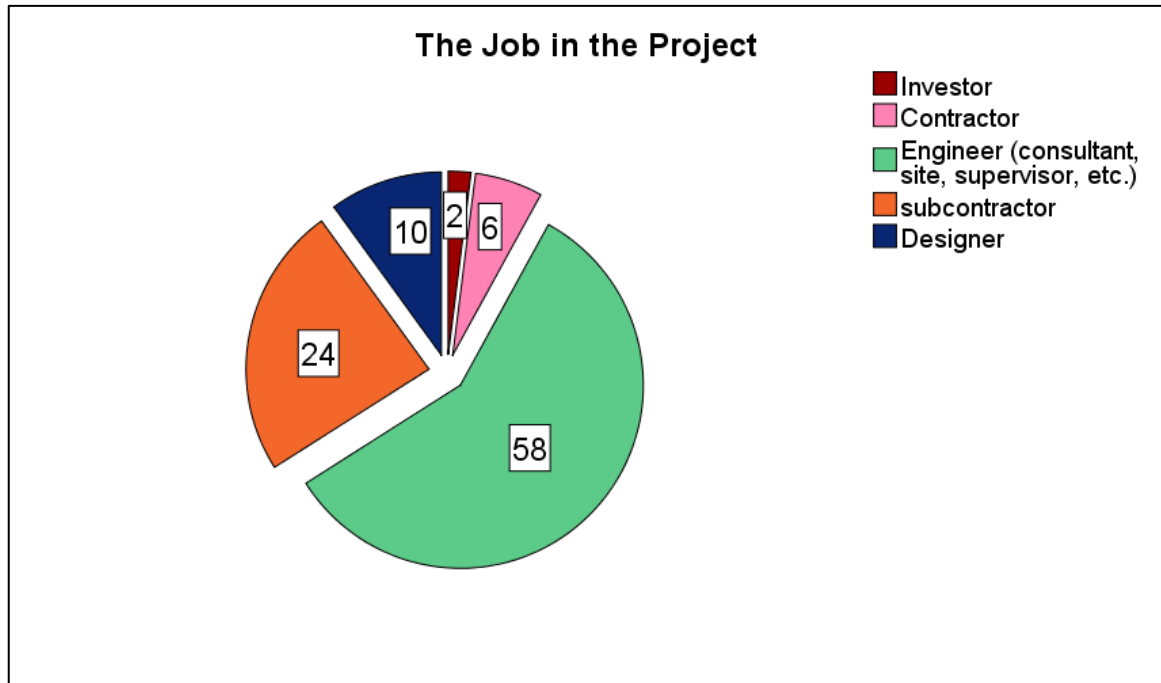


Figure 4.6: Graphical Representation of Respondents' Demographic Data Linked to Type of Job.

Table 4.13 illustrates job position of the respondents.

Table 4.13: Job Position of the Respondents.

<i>Variable</i>	<i>Category</i>	<i>Frequency</i>	<i>Percentage (%)</i>
<i>Job Position</i>	Top Management	9	8.8
	Middle Management	79	77.5
	Specialist	12	11.8

Table 4.14 describes further information on the SPSS analysis of job position.

Table 4.14: Further Information on The SPSS Analysis of Job Position.

<i>Job Position</i>					
Classification		Frequency	%	Valid %	Cumulative %
Valid	Top Management	9	8.80	9.00	9.00
	Middle Management	79	77.5	79.0	88.0
	Specialist	12	11.8	12.0	100.0
	Total	100	98.0	100.0	
Missing	System	2	2.0		
Total		102	100.0		

The study included three job positions for responders, distributed as follows (top management, middle management, and specialist). Figure 4.7 shows the rates of job sites for the study. It was noted from the study results that the highest percentage was for respondents who occupy the role of middle management with a rate (of 77.5%), followed by the role of specialist with a portion (11.8%).

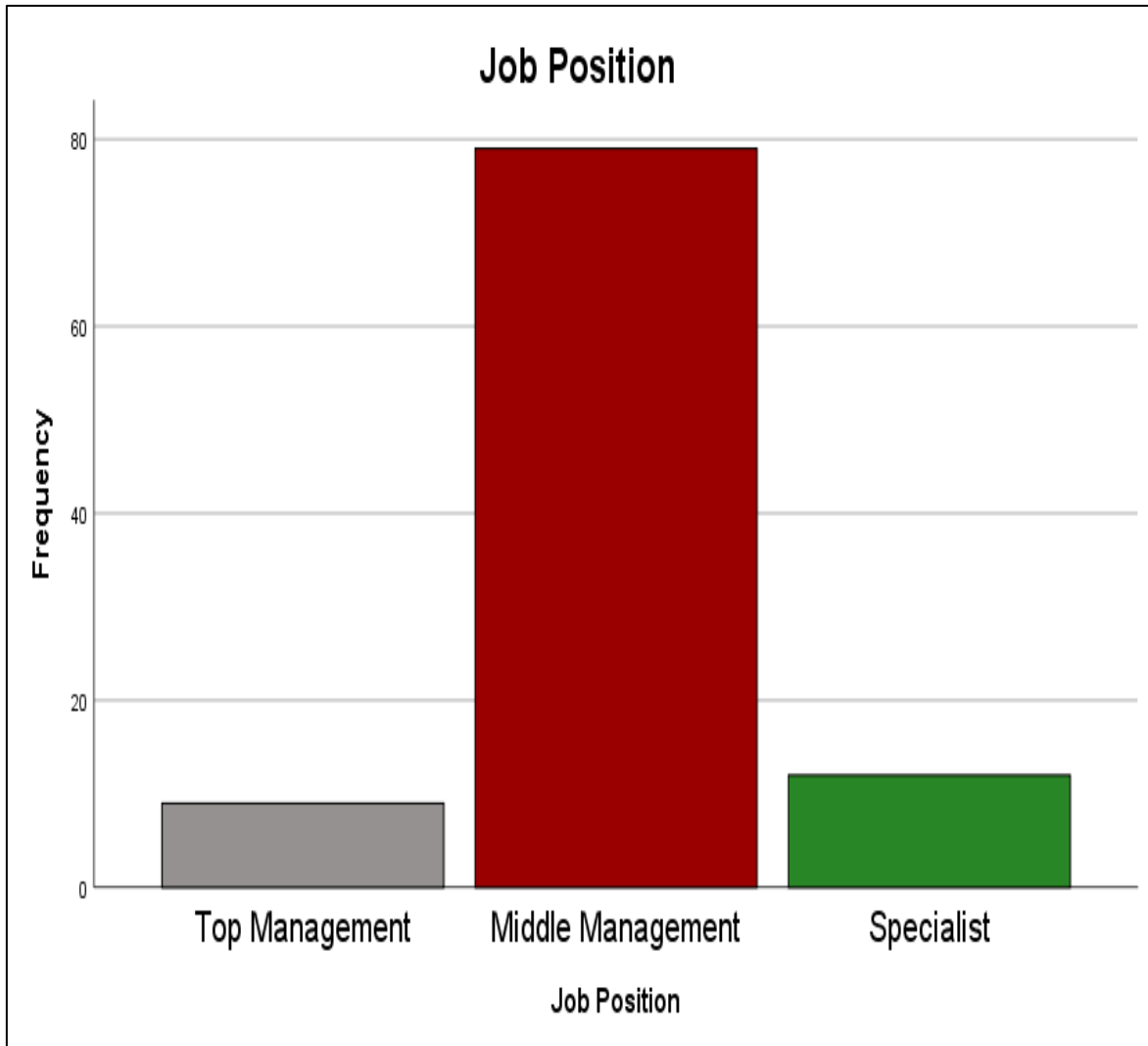


Figure 4.7: Graphical Representation of Respondents' Demographic Data Linked to Job Position.

Table 4.15 illustrates type of projects of the respondents.

Table 4.15: Type of Projects of the Respondents.

Variable	Category	Frequency	Percentage (%)
Where did you work on construction projects?	Domestic	79	77.5
Where did you work on construction projects?	International	14	13.7
	Domestic and International	7	6.9

Table 4.16 illustrates further information on the SPSS analysis of the type of projects.

Table 4.16: Further Information on The SPSS Analysis of The Type of Projects.

<i>Where did you work on construction projects?</i>					
Classification		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Domestic	79	77.5	79.0	79.0
	International	14	13.7	14.0	93.0
	Domestic and International	7	6.9	7.0	100.0
	Total	100	98.0	100.0	
Missing	System	2	2.0		
Total		102	100.0		

A question was asked to the respondents (Where did you work on the construction projects?), and the answers were distributed among (domestic, international, and domestic

international). The most significant percentage of respondents working on household projects reached (77.5%), followed by international projects with (13.7%). Figure 4.8 indicates the distribution associated with construction projects for the study sample.

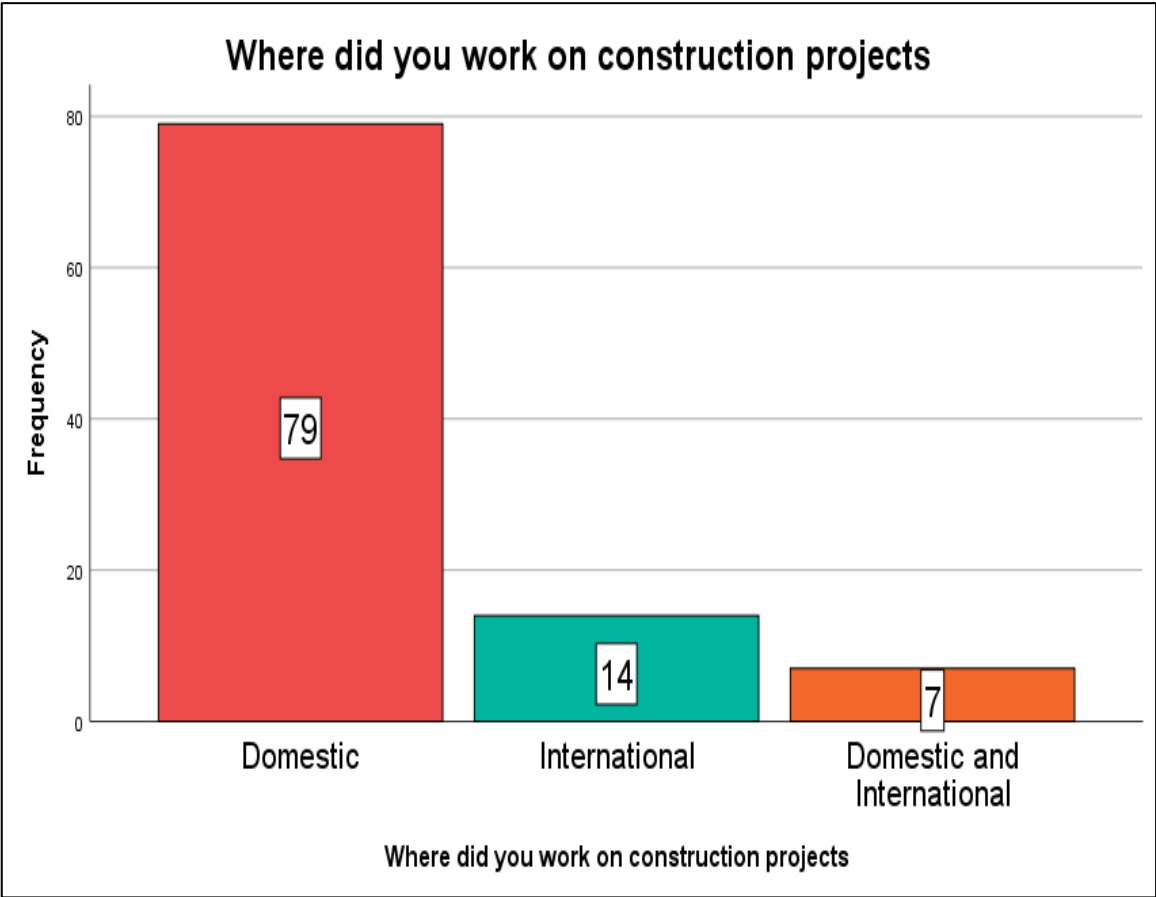


Figure 4.8: Graphical Representation of Respondents’ Demographic Data Linked to Type of Projects.

Table 4.17 illustrates the answers related to the question: “Have you worked with international companies that have construction projects inside Iraq that work with the risk management curriculum? (Risk management plan)”.

Table 4.17: Answers of The Respondents Related to If They Work in Risk Management.

Variable	Category	Frequency	Percentage (%)
Have you worked with risk management plan	Yes	19	18.6
	No	81	79.4

Table 4.18 indicates further information on the SPSS analysis of whether respondents work in risk management.

Table 4.18: Further Information on The SPSS Analysis of Whether Respondents Work in Risk Management.

<i>Have you worked with international companies that have construction projects inside Iraq that work with the risk management curriculum? (Risk management plan)</i>					
Classification		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	19.0	18.60	19.00	19.00
	No	81.0	79.40	81.00	100.00
	Total	100.0	98.00	100.00	
Missing	System	2.00	2.00		
Total		102.0	100		

The respondents were asked (Have you worked with international companies that have construction projects inside Iraq that work with the risk management curriculum? (Risk management plan)). The answers were distributed (Yes and No). Figure 4.9 shows the distribution of respondents' answers. The most significant percentage of respondents who do not work with international companies that have construction projects inside Iraq that work with the risk management curriculum was (79.4%), while the percentage of employed who

work with international companies that have construction projects inside Iraq that work with the risk management curriculum reached (18.6%).

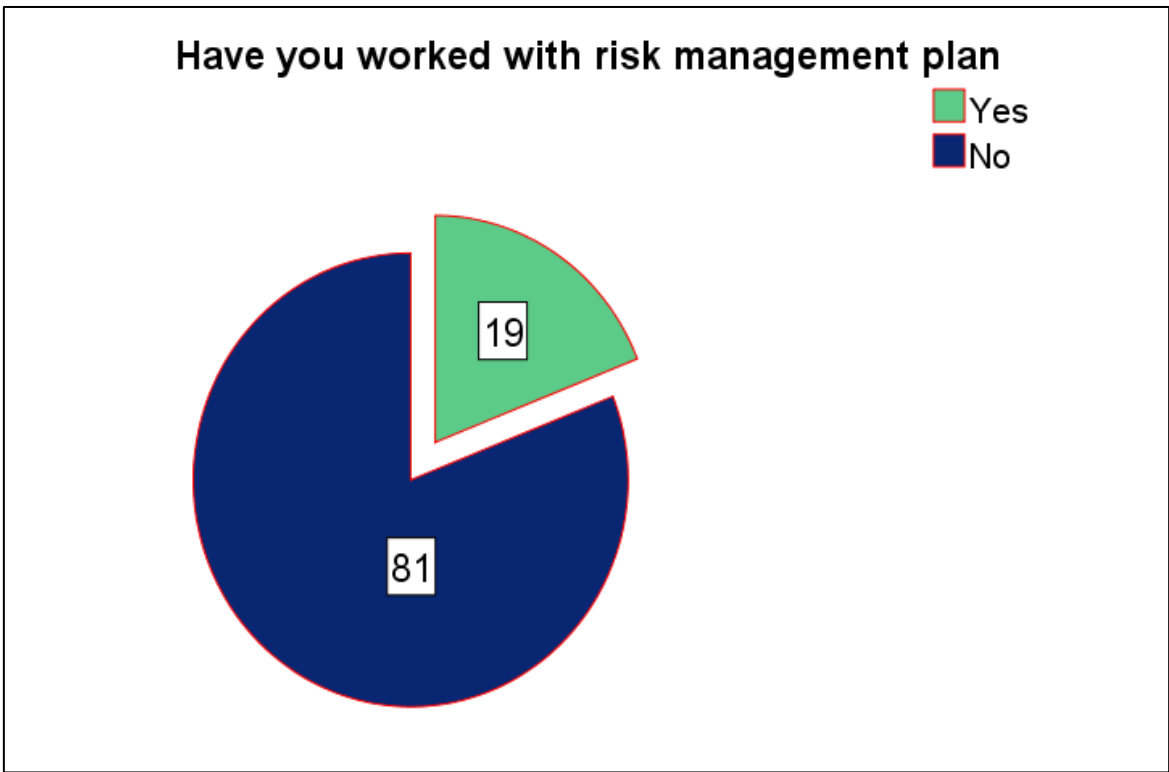


Figure 4.9: Graphical Representation of Respondents’ Demographic Data Linked to Whether Respondents Work in Risk Management.

4.3 RESULTS OF RESEARCH OBJECTIVE ANALYSIS

The second part of the questionnaire aims to identify and rank the factors that affect losses resulting from exceeding the specified time for completion and its impact on the status of the project and delay in utilizing services by classifying the elements on the fifth Likert scale as follows: (1- Very strong, 2- Quite strong, 3 Moderate, 4- Rather low, 5- Very low).

4.3.1 Chi-Square Test

Table 4.19 present the Chi-Square test results.

Table 4.19: Chi-Square Test Results.

<i>Chi-Square Tests</i>			
Classification	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	6.878 ^a	3	.076
Likelihood Ratio	9.041	3	.029
Linear-by-Linear Association	4.816	1	.028
N of Valid Cases	100		
a. Five cells (62.5%) have an expected count of less than 5. The minimum expected count is .38.			

The study's results showed that the chi-square value amounted to (0.076), less than 50%. Table 4.19 shows the chi-square value of the study. This value indicates that the study sample fell in the acceptance region. Accordingly, the alternative hypothesis is accepted, and the null hypothesis is rejected according to the degrees of freedom.

4.3.2 Regression Coefficient Test

Table 4.20 shows the results of regression test.

Table 4.20: Regression Test Results.

ANOVA ^a						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	1.370	1	1.370	9.575	.003 ^b
	Residual	14.020	98	.143		
	Total	15.390	99			
a. Dependent Variable: Gender						
b. Predictors: (Constant), The Job in the Project						

The regression test is a statistical analysis that attempts to predict the value of one variable's future in light of the values of another variable. The regression test illustrates the form and nature of the connection between the two variables and graphically and statistically establishes the direction of the relationship (the regression line). Table 4.20 of the study's findings demonstrates that the regression value equaled 0.003, which is even less than 0.05. This feature suggests that the computed (F) value is higher than the tabular (F) value at degrees of freedom, which implies that the alternative hypothesis is accepted and the null hypothesis is disregarded.

4.3.3 Correlation Coefficient Test

Table 4.21 describes the correlation coefficient test results (Group 1 and 2).

Table 4.21: Correlation Coefficient Test Results (Group 1 and 2).

Correlations			
Classification		Group 1	Group 2
Group 1	Pearson Correlation	1	.119
	Sig. (two-tailed)		.238
	N	100	100
Group 2	Pearson Correlation	.119	1
	Sig. (two-tailed)	.238	
	N	100	100

The correlation test is based on determining the strength of the relationship between two variables whose value ranges between (1, -1). Referring to the results of the study that shows the relationship between (Group 1 and Group 2). Also, according to Table 4.21, there is a statistically significant link (0.119, or greater than 50%) between the two variables. Therefore, the null hypothesis is rejected and alternative hypothesis is accepted.

Table 4.22 indicate the correlation coefficient test results (Group 8 and 9).

Table 4.22: Correlation Coefficient Test Results (Group 8 and 9).

Correlations			
Classification		Group 8	Group 9
Group 8	Pearson Correlation	1	.280**
	Sig. (two-tailed)		.005
	N	100	100
Group 9	Pearson Correlation	.280**	1
	Sig. (two-tailed)	.005	
	N	100	100
**. The 0.01 level of significance for correlation (two-tailed).			

The same applies to the relationship between (Group 8 and Group 9). The research findings linked to this SPSS analysis affirmed a statistically significant connection between the two factors with a value of (0.280), which is greater than fifty percent, with an error rate of 0.01. Therefore, the null hypothesis can be rejected. At the same time, the alternative hypothesis can be accepted. In addition, the outcomes of the study illustrated the correlation coefficient between each element in the field of “Delaying Projects Reasons”, which is divided into the following points:

- a. Cost, quality, and time
- b. The executing companies
- c. Project management
- d. Lack of proper planning
- e. Financial allocations
- f. The significant (security) conditions

Table 4.23 presents the findings of the correlation coefficient test for Group 2.

Table 4.23: The Findings of the Correlation Coefficient Test for Group 2.

Construction Mismanagement Risks					
Category		Q15	Q16	Q17	Q18
What is the impact of the mentioned factors on cost overruns of the construction projects?	Pearson Correlation	1	10.00**	.968**	.957**
	Sig. (two-tailed)		0.0	0.0	0.0
	N	100	100	100	100
What is the impact of the mentioned factors related to the delay in completing the construction projects?	Pearson Correlation	10.00**	1	.968**	.957**
	Sig. (two-tailed)	0.0		0.0	0.0
	N	100	100	100	100
How often does it appear?	Pearson Correlation	.968**	.968**	1	.989**
	Sig. (two-tailed)	0.0	0.0		0.0
	N	100	100	100	100
What is the impact of these factors on the occurrence of other risks?	Pearson Correlation	.957**	.957**	.989**	1
	Sig. (two-tailed)	0.0	0.0	0.0	
	N	100	100	100	100
**. The 0.01 level of significance for correlation (two-tailed).					

The results of the study showed the correlation coefficient between each element in the field of “Construction Mismanagement Risks”, which is divided into the following points:

- a. Lack of planning and management
- b. Lack of scope clarity or changes in the project’s scope and cost
- c. Poor management

- d. Inadequate site planning and management
- e. Delay in making project decisions

Also, Table 4.23's findings demonstrate that the correlation coefficients are significant statistically at the significance level. 0.05, the field is regarded as accurate for the value it is intended to measure. The findings of the correlation coefficient test for Group 3 are shown in Table 4.24.

Table 4.24: The Results of The Correlation Coefficient Test For Group 3.

<i>Communication Risks</i>					
Category		Q19	Q20	Q21	Q22
What is the impact of the mentioned factors on cost overruns of the construction projects?	Pearson Correlation	1	10.00**	.899**	.840**
	Sig. (two-tailed)		0.0	0.0	0.0
	N	100	100	100	100
What is the impact of the mentioned factors on the delay in completing the construction projects?	Pearson Correlation	10.00**	1	.899**	.840**
	Sig. (two-tailed)	0.00		0.0	0.0
	N	100	100	100	100
How often does it appear?	Pearson Correlation	.899**	.899**	1	.788**
	Sig. (two-tailed)	0.0	0.0		0.0
	N	100	100	100	100

Table 4.24: The Results of The Correlation Coefficient Test For Group 3 “Table Continued”

What is the impact of these factors on the occurrence of other risks?	Pearson Correlation	.840**	.840**	.788**	1
	Sig. (two-tailed)	0.0	0.0	0.0	
	N	100	100	100	100
**. The 0.01 level of significance for correlation (two-tailed).					

The results of the study showed the correlation coefficient between each element in the field of “Communication Risks ”, which is divided into the following points:

- i. Poor communication with clients/ imprecise expectations
- ii. Poor communication between the parties

The findings in Table 4.24 further demonstrate that the correlation coefficients are significant statistically at the significance level. Since the field has a precision of 0.05, its intended use is presumed to be valid. The correlation coefficient test results for Group 4 are shown in Table 4.25.

Table 4.25: The Results of The Correlation Coefficient Test For Group 4.

<i>Financial Risks</i>					
Category		Q23	Q24	Q25	Q26
What is the impact of the mentioned factors on cost overruns of the construction projects?	Pearson Correlation	1	10.00**	.847**	.827**
	Sig. (two-tailed)		0.0	0.0	0.0
	N	100	100	100	100

Table 4.25: The Results of The Correlation Coefficient Test For Group 4 “Table Continued”

What is the impact of the mentioned factors on the delay in completing the construction projects?	Pearson Correlation	10.00**	1	.847**	.827**
	Sig. (two-tailed)	0.0		0.0	0.0
	N	100	100	100	100
How often does it appear?	Pearson Correlation	.847**	.847**	1	.755**
	Sig. (two-tailed)	0.0	0.0		0.0
	N	100	100	100	100
What is the impact of these factors on the occurrence of other risks?	Pearson Correlation	.827**	.827**	.755**	1
	Sig. (two-tailed)	0.00	0.00	0.00	
What is the impact of these factors on the occurrence of other risks?	N	100	100	100	100
**. The 0.01 level of significance for correlation (two-tailed).					

The results of the study showed the correlation coefficient between each element in the field of “Financial Risks ”, which is divided into the following points:

- i. Financial problems of the client
- ii. Financial issues of the Contractor
- iii. Delaying or refusing payments to contractors, subcontractors, or workers
- iv. External economic factors such as (fluctuations in price and interest rates, inflation, and recession)

Also, the findings in Table 4.25 demonstrate the statistical significance of the specified correlation coefficients at the significance level. 0.05, the field is regarded as accurate for

the value it is intended to measure. The findings of the correlation coefficient test for Group 5 are shown in Table 4.26.

Table 4.26: The Results of The Correlation Coefficient Test For Group 5.

<i>Legal Risks</i>					
Category		Q27	Q28	Q29	Q30
What is the impact of the mentioned factors on cost overruns of the construction projects?	Pearson Correlation	1	10.00**	.475**	.374**
	Sig. (two-tailed)		0.0	0.0	0.0
	N	100	100	100	100
What is the impact of the mentioned factors on the delay in completing the construction projects?	Pearson Correlation	10.00**	1	.475**	.374**
	Sig. (two-tailed)	0.0		0.0	0.0
	N	100	100	100	100
How often does it appear?	Pearson Correlation	.475**	.475**	1	.245*
	Sig. (two-tailed)	0.0	0.0		.014
	N	100	100	100	100
What is the impact of these factors on the occurrence of other risks?	Pearson Correlation	.374**	.374**	.245*	1
	Sig. (two-tailed)	0.0	0.0	.014	
	N	100	100	100	100

Table 4.26: The Results of The Correlation Coefficient Test For Group 5 “Table Continued”

**.	The 0.01 level of significance for correlation (two-tailed).
*.	The 0.05 level of significance for correlation (two-tailed).

The results of the study showed the correlation coefficient between each element in the field of “Legal Risks ”, which is divided into the following points:

- i. Contractual weakness (weakness in terms of the contract)
- ii. Inconsistencies and mistakes in the contract documents
- iii. Terrorism and sabotage
- iv. Changes in applicable law during project implementation

Also, the findings in Table 4.26 demonstrate the statistical significance of the specified correlation coefficients at the significance level. 0.05, the field is regarded as accurate for the value it is intended to measure. The findings of the correlation coefficient test for Group 6 are shown in Table 4.27.

Table 4.27: The Results of The Correlation Coefficient Test For Group 6.

<i>Market Risks</i>					
Category		Q31	Q32	Q33	Q34
What is the impact of the mentioned factors on cost overruns of the construction projects?	Pearson Correlation	1	10.00**	.866**	10.00**
	Sig. (two-tailed)		0.00	0.00	0.00
What is the impact of the mentioned factors on cost overruns of the construction projects?	N	100	100	100	100

Table 4.27: The Results of The Correlation Coefficient Test For Group 6 “Table Continued”

What is the impact of the mentioned factors on the delay in completing the construction projects?	Pearson Correlation	10.00**	1	.866**	10.00**
	Sig. (two-tailed)	0.00		0.00	0.00
	N	100	100	100	100
How often does it appear?	Pearson Correlation	.866**	.866**	1	.866**
	Sig. (two-tailed)	0.0	0.0		0.0
	N	100	100	100	100
What is the impact of these factors on the occurrence of other risks?	Pearson Correlation	10.00**	10.00**	.866**	1
	Sig. (two-tailed)	0.0	0.0	0.0	
	N	100	100	100	100
**. The 0.01 level of significance for correlation (two-tailed).					

The results of the study showed the correlation coefficient between each element in the field of “Market Risks ”, which is divided into the following points:

- i. Poor transportation and logistics performance
- ii. Lowest bidding procurement method
- iii. Delays in the delivery of materials

A further finding from Table 4.27's results is that the correlation coefficients are significant statistically at the significance level. Since the field has a precision of 0.05, its intended use is presumed to be valid. The correlation coefficient test results for Group 7 are displayed in Table 4.28.

Table 4.28: The Results of The Correlation Coefficient Test For Group 7.

<i>Policy and Politics Risks</i>					
Category		Q35	Q36	Q37	Q38
What is the impact of the mentioned factors on cost overruns of the construction projects?	Pearson Correlation	1	10.00**	.214*	.495**
	Sig. (two-tailed)		0.00	.032	0.00
	N	100	100	100	100
What is the impact of the mentioned factors on the delay in completing the construction projects?	Pearson Correlation	10.00**	1	.214*	.495**
	Sig. (two-tailed)	0.00		.032	0.00
	N	100	100	100	100
How often does it appear?	Pearson Correlation	.214*	.214*	1	-.133-
	Sig. (two-tailed)	.032	.032		.188
	N	100	100	100	100
What is the impact of these factors on the occurrence of other risks?	Pearson Correlation	.495**	.495**	-.133-	1
	Sig. (two-tailed)	0.00	0.00	.188	
	N	100	100	100	100
**. The 0.01 level of significance for correlation (two-tailed).					
*. The 0.05 level of significance for correlation (two-tailed).					

The results of the study showed the correlation coefficient between each element in the field of "Policy and Politics Risks ", which is divided into the following points:

- i. Excessive bureaucracy
- ii. Delays due to complex political situation

The outcome in Table 4.28 also demonstrates the statistical significance of the correlation coefficients at the significance level. 0.05, the field is regarded as accurate for the value it is

intended to measure. The findings of the correlation coefficient test for Group 8 are shown in Table 4.29.

Table 4.29: The Results of The Correlation Coefficient Test For Group 8.

<i>Technical Risks</i>					
Category		Q39	Q40	Q41	Q42
What is the impact of the mentioned factors on cost overruns of the construction projects?	Pearson Correlation	1	10.00**	.816**	.706**
	Sig. (two-tailed)		0.0	0.0	0.0
	N	100	100	100	100
What is the impact of the mentioned factors on the delay in completing the construction projects?	Pearson Correlation	10.00**	1	.816**	.706**
	Sig. (two-tailed)	0.0		0.0	0.0
	N	100	100	100	100
How often does it appear?	Pearson Correlation	.816**	.816**	1	.788**
	Sig. (two-tailed)	0.0	0.0		0.0
	N	100	100	100	100
What is the impact of these factors on the occurrence of other risks?	Pearson Correlation	.706**	.706**	.788**	1
	Sig. (two-tailed)	0.0	0.0	0.0	
	N	100	100	100	100
**. The 0.01 level of significance for correlation (two-tailed).					

The results of the study showed the correlation coefficient between each element in the field of "Technical Risks ", which is divided into the following points:

- i. Variation works / Change order
- ii. Unforeseen ground conditions (lack of site investigations)
- iii. Time underestimation (inadequate time)

The results in Table 4.29 further demonstrate that the correlation coefficients provided are statistical significance at the significance level. Since the field has a precision of 0.05, its intended use is presumed to be valid. The correlation coefficient test results for Group 9 are presented in Table 4.30.

Table 4.30: The Results of The Correlation Coefficient Test For Group 9.

<i>Design Risks</i>					
Category		Q43	Q44	Q45	Q46
What is the impact of the mentioned factors on cost overruns of the construction projects?	Pearson Correlation	1	.991**	.969**	.975**
	Sig. (two-tailed)		0.00	0.00	0.00
	N	100	100	100	100
What is the impact of the mentioned factors on the delay in completing the construction projects?	Pearson Correlation	.991**	1	.975**	.982**
	Sig. (two-tailed)	0.00		0.00	0.00
	N	100	100	100	100
How often does it appear?	Pearson Correlation	.969**	.975**	1	.956**
	Sig. (two-tailed)	0.00	0.00		0.00
	N	100	100	100	100

Table 4.30: The Results of The Correlation Coefficient Test For Group 9 “Table Continued”

What is the impact of these factors on the occurrence of other risks?	Pearson Correlation	.975**	.982**	.956**	1
	Sig. (two-tailed)	0.00	0.00	0.00	
	N	100	100	100	100
**. The 0.01 level of significance for correlation (two-tailed).					

The results of the study showed the correlation coefficient between each element in the field of “Design Risks”, which is divided into the following points:

- i. Errors in design or changes
- ii. Design and drawing flaws
- iii. Inadequate architecture design

The findings are also displayed in Table 4.30, where it is evident that the correlation coefficients are statistically meaningful at the .05 level. Since the field has a precision of 0.05, its intended use is presumed to be valid. The correlation coefficient test results for Group 10 are shown in Table 4.31.

Table 4.31: The Results of The Correlation Coefficient Test For Group 10.

<i>Human Resources Risks</i>					
Category		Q47	Q48	Q49	Q50
What is the impact of the mentioned factors on cost overruns of the construction projects?	Pearson Correlation	1	10.00**	.474**	.444**
	Sig. (two-tailed)		0.0	0.0	0.0
	N	100	100	100	100

Table 4.31: The Results of The Correlation Coefficient Test For Group 10 “Table Continued”

What is the impact of the mentioned factors on the delay in completing the construction projects?	Pearson Correlation	10.00**	1	.474**	.444**
	Sig. (two-tailed)	0.0		0.0	0.0
	N	100	100	100	100
How often does it appear?	Pearson Correlation	.474**	.474**	1	.659**
	Sig. (two-tailed)	0.0	0.0		0.0
	N	100	100	100	100
What is the impact of these factors on the occurrence of other risks?	Pearson Correlation	.444**	.444**	.659**	1
	Sig. (two-tailed)	0.0	0.0	0.0	
	N	100	100	100	100
**. The 0.01 level of significance for correlation (two-tailed).					

The results of the study showed the correlation coefficient between each element in the field of “Human Resources Risks” which is divided into the following points:

- i. Insufficient number/ lack of workers
- ii. Poor number/lack of qualified personnel

The results in Table 4.31 further demonstrate the statistical significance of the correlation coefficients at the significance level. 0.05, the field is regarded as accurate for the value it is intended to measure. The findings of the correlation coefficient test for Group 11 are shown in Table 4.32.

Table 4.32: The Results of The Correlation Coefficient Test For Group 11.

<i>Risks in Mismanagement Quality</i>					
Category		Q51	Q52	Q53	Q54
What is the impact of the mentioned factors on cost overruns of the construction projects?	Pearson Correlation	1	.987**	.879**	.765**
	Sig. (two-tailed)		0.0	0.0	0.0
	N	100	100	100	100
What is the impact of the mentioned factors on the delay in completing the construction projects?	Pearson Correlation	.987**	1	.883**	.752**
	Sig. (two-tailed)	0.0		0.0	0.0
	N	100	100	100	100
How often does it appear?	Pearson Correlation	.879**	.883**	1	.894**
	Sig. (two-tailed)	0.0	0.0		0.0
	N	100	100	100	100
What is the impact of these factors on the occurrence of other risks?	Pearson Correlation	.765**	.752**	.894**	1
	Sig. (two-tailed)	0.0	0.0	0.0	
	N	100	100	100	100
**. The 0.01 level of significance for correlation (two-tailed).					

The results of the study showed the correlation coefficient between each element in the field of “Risks in Mismanagement Quality”, which is divided into the following points:

- i. Reworks due to poor quality or flaws in execution
- ii. Poor quality or damage to building materials

The stated correlation coefficients are statistically meaningful at the significance level, as shown by Table 4.32. 0.05, the field is regarded as accurate for the value it is intended to measure. The findings of the correlation coefficient test for Group 12 are shown in Table 4.33.

Table 4.33: The Results of The Correlation Coefficient Test For Group 12.

<i>Safety Risks</i>					
Category		Q55	Q56	Q57	Q58
What is the impact of the mentioned factors on cost overruns of the construction projects?	Pearson Correlation	1	.974**	.856**	.663**
	Sig. (two-tailed)		0.0	0.0	0.0
	N	100	100	100	100
What is the impact of the mentioned factors on the delay in completing the construction projects?	Pearson Correlation	.974**	1	.808**	.608**
	Sig. (two-tailed)	0.0		0.0	0.0
	N	100	100	100	100
How often does it appear?	Pearson Correlation	.856**	.808**	1	.837**
	Sig. (two-tailed)	0.0	0.0		0.0
	N	100	100	100	100
What is the impact of these factors on the occurrence of other risks?	Pearson Correlation	.663**	.608**	.837**	1
	Sig. (two-tailed)	0.0	0.0	0.0	
	N	100	100	100	100
**. The 0.01 level of significance for correlation (two-tailed).					

The results of the study showed the correlation coefficient between each element in the field of "Safety Risks ", which is divided into the following points:

- i. Lack of safety in construction

- ii. Delays due to incompetence or lack of experience of workers
- iii. Random events (e.g., accidents)

The stated correlation coefficients are significant statistically at the significance level, as shown by Table 4.33. 0.05, the field is regarded as accurate for the value it is intended to measure. The findings of the correlation coefficient test for Group 13 are shown in Table 4.34.

Table 4.34: The Results of The Correlation Coefficient Test For Group 13.

<i>Health Risks</i>					
Category		Q59	Q60	Q61	Q62
What is the impact of the mentioned factors on cost overruns of the construction projects?	Pearson Correlation	1	.991**	.668**	.539**
	Sig. (two-tailed)		0.0	0.0	0.0
	N	100	100	100	100
What is the impact of the mentioned factors on the delay in completing the construction projects?	Pearson Correlation	.991**	1	.621**	.503**
	Sig. (two-tailed)	0.0		0.0	0.0
	N	100	100	100	100
How often does it appear?	Pearson Correlation	.668**	.621**	1	.866**
	Sig. (two-tailed)	0.0	0.0		0.0
	N	100	100	100	100

Table 4.34: The Results of The Correlation Coefficient Test For Group 13 “Table Continued”

What is the impact of these factors on the occurrence of other risks?	Pearson Correlation	.539**	.503**	.866**	1
	Sig. (two-tailed)	0.0	0.0	0.0	
	N	100	100	100	100
**. The 0.01 level of significance for correlation (two-tailed).					

The results of the study showed the correlation coefficient between each element in the field of “Health Risks ”, which is divided into the following points:

- i. Illness or death of workers
- ii. Low productivity of the workers (poor working conditions, low morale)
- iii. Bad weather or climatic conditions

Also, Table 4.34 shows that the indicated correlation coefficients are statistically significant at the significance level. 0.05, so the field is considered valid for what it is set to measure.

4.3.4 Mean, Standard Deviation, and Z-value

The following table shows the factors used, and they are listed in groups:

- i. Delaying Projects Reasons.
- ii. The Risks of Delaying.

Table 4.35: The Results of Arithmetic Mean and Order of Delaying Projects Reasons.

Paragraph	Z value	Standard Deviation	Arithmetic Mean
Is the main element in your opinion (cost), (quality), (time), or two of them, or all of them in the implementation of projects?	3.108	1.094	3.34

Table 4.35: The Results of Arithmetic Mean and Order of Delaying Projects Reasons “Table Continued”

Do you think that projects of different sizes need to be completed according to the contracts concluded for them?	-63.01	0.302	1.10
Do you think that the main reason for the delay in projects is the executing companies?	-5.166	0.736	2.62
Do you think that the main reason for the delay in the project is project management?	-18.482	0.822	1.48
Do you think that the main reason for the delay in the project is the lack of proper planning for them?	-45.907	0.394	1.19
Do you think that the main reason for the delay in the project is the financial allocations?	-63.016	0.302	1.10
Do you think that the major reason delaying projects is the majeure (security) conditions?	-52.806	0.197	1.96
Do you think that the major cause related to the delay in projects is all of the above-mentioned paragraphs, all or some of them?	-40.898	0.443	1.19
Do you think that the entry of engineering materials into the project with the required qualities is a reason for the delaying implementation?	-47.936	0.219	1.95
Could the delay in projects be due to poor design?	-48.474	0.378	1.17

Table 4.35: The Results of Arithmetic Mean and Order of Delaying Projects Reasons. “Table Continued”

Do you think the presence of the consultant within the project is important to resolve matters quickly and to avoid delays?	-53.336	0.349	1.14
Do you think that delays in projects only happen to projects that are located in hot places?	-60.077	0.171	1.97
Do you think that the paragraphs of preparing designs and implementation should be distributed to all ministries and not to ministries and specialized companies?	-32.045	0.359	1.85
Do you depend in all projects of the public and private sectors on the basic elements required for the different contracts?	-30.991	0.378	1.83

Figure 4.10 illustrates a graphical representation of arithmetic mean of delaying projects reasons.

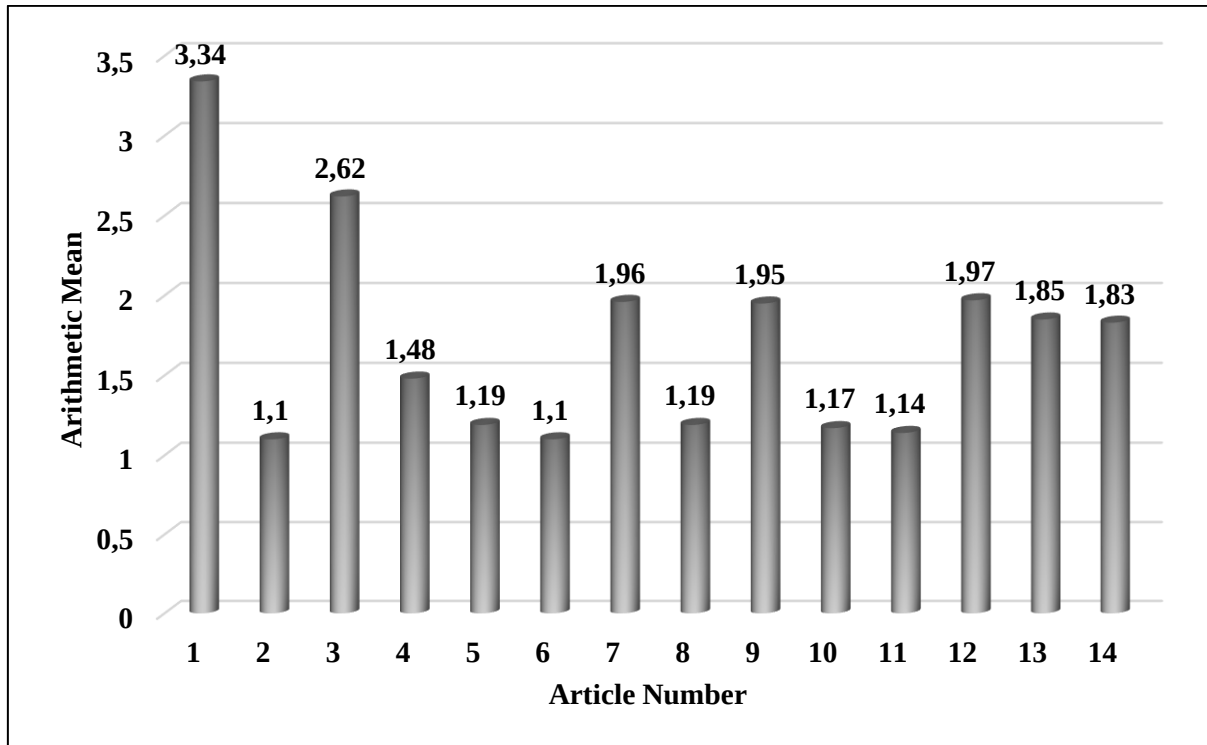


Figure 4.10: Graphical Representation of Arithmetic Mean of Delaying Projects Reasons.

The study's results showed that group questions (Delaying Projects Reasons) were distributed according to the arithmetic mean (see table 4.35).

- i. Is the main element in your opinion (cost), (quality), (time), two of them, or all of them in the implementation of projects? (3.34)
- ii. Do you think projects of different sizes need to be completed according to their contracts? (1.10)
- iii. Do you think the major cause related to the project delay is the executing companies? (2.62)
- iv. Do you think the major cause related to the delay in the project is project management? (1.48)
- v. Do you think the major cause related to the delay in the project is the lack of proper planning for them? (1.19)
- vi. Do you think the major cause related to the delay in the project is the financial allocations? (1.10)
- vii. Do you think that the main reason delaying projects are the major (security) conditions? (1.96)

- viii. Do you think that the major cause related to the project delay is all of the paragraphs as mentioned above or some of them? (1.19)
- ix. Do you think the entry of engineering materials into the project with the required qualities is a reason for the delayed implementation? (1.95)
- x. Could the delay in projects be due to poor design? (1.17)
- xi. Do you think the consultant's presence within the project is important to resolve matters quickly and avoid delays? (1.14)
- xii. Do you believe that delays in projects only happen to projects that are located in hot places? (1.97)
- xiii. Do you think the paragraphs on preparing designs and implementation should be distributed to all ministries and not to ministries and specialized companies? (1.85)
- xiv. Do you depend on all projects of the public and private sectors on the essential elements required for the different contracts? (1.83)

Table 4.36 describes the results of arithmetic mean and order of the construction mismanagement risks.

Table 4.36: The Results of Arithmetic Mean and Order of The Construction Mismanagement Risks.

Paragraph	Z value	Standard Deviation	Arithmetic Mean
Lack of planning and management	-26.407	0.682	1.20
Lack of scope clarity or changes in project's scope and cost	-26.407	0.682	1.20

Table 4.36: The Results of Arithmetic Mean and Order of The Construction Mismanagement Risks. “Table Continued”

Poor management	-27.416	0.667	1.17
Inadequate site planning and management	-27.777	0.662	1.16
Delay in making project decisions	-25.215	0.674	1.30

Figure 4.11 presents a graphical representation of arithmetic mean of the construction mismanagement risks.

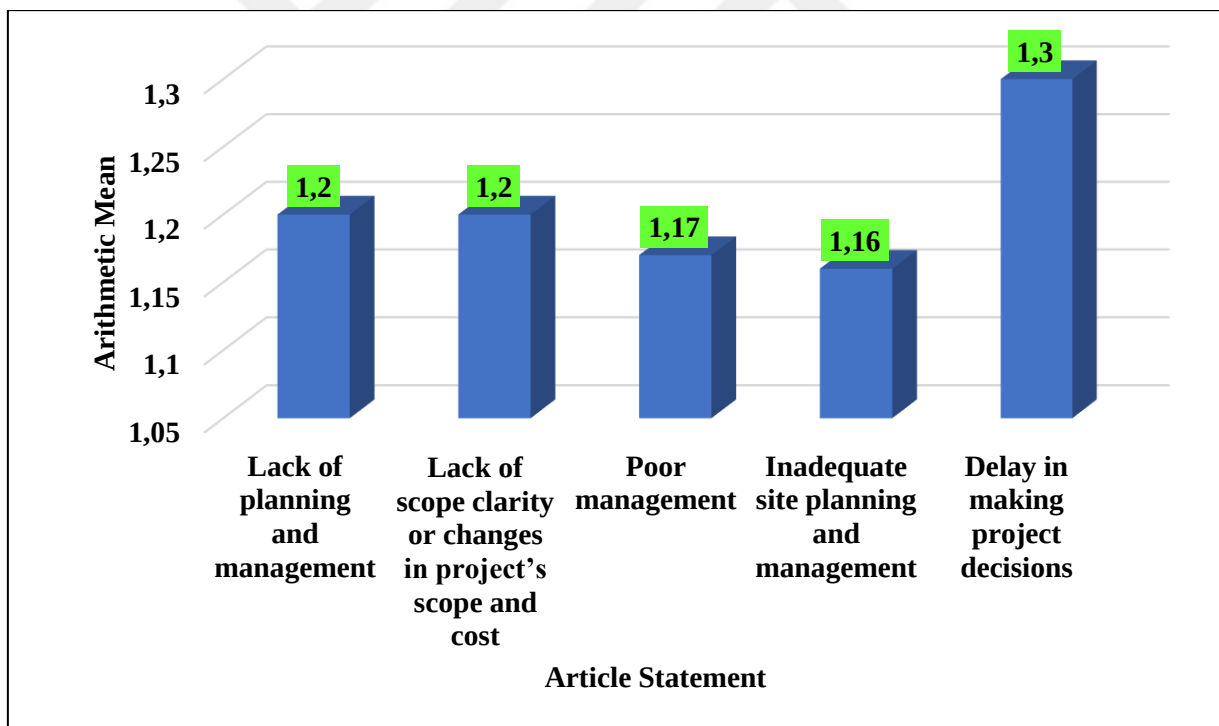


Figure 4.11: Graphical Representation of Arithmetic Mean of The Construction Mismanagement Risks.

The statistical analysis results showed the average and standard deviation for every one of the Construction Mismanagement Risks sub-factors. These factors are arranged in descending order. See table (4.36).

- i. Delay in making project decisions (1.30)
- ii. Lack of planning and management (1.20)
- iii. Lack of scope clarity or changes in the project's scope and cost (1.20)
- iv. Poor management (1.17)
- v. Inadequate site planning and management (1.16)

Table 4.37 describes the results of arithmetic mean and order of the communication risks.

Table 4.37: The Results of Arithmetic Mean and Order of The Communication Risks.

Paragraph	Z value	Standard Deviation	Arithmetic Mean
Poor communication with client/ imprecise expectations	-25.215	0.674	1.30
Poor communication between the parties	-16.443	0.937	1.46

Figure 4.12 illustrates a graphical representation of arithmetic mean of the communication risks.

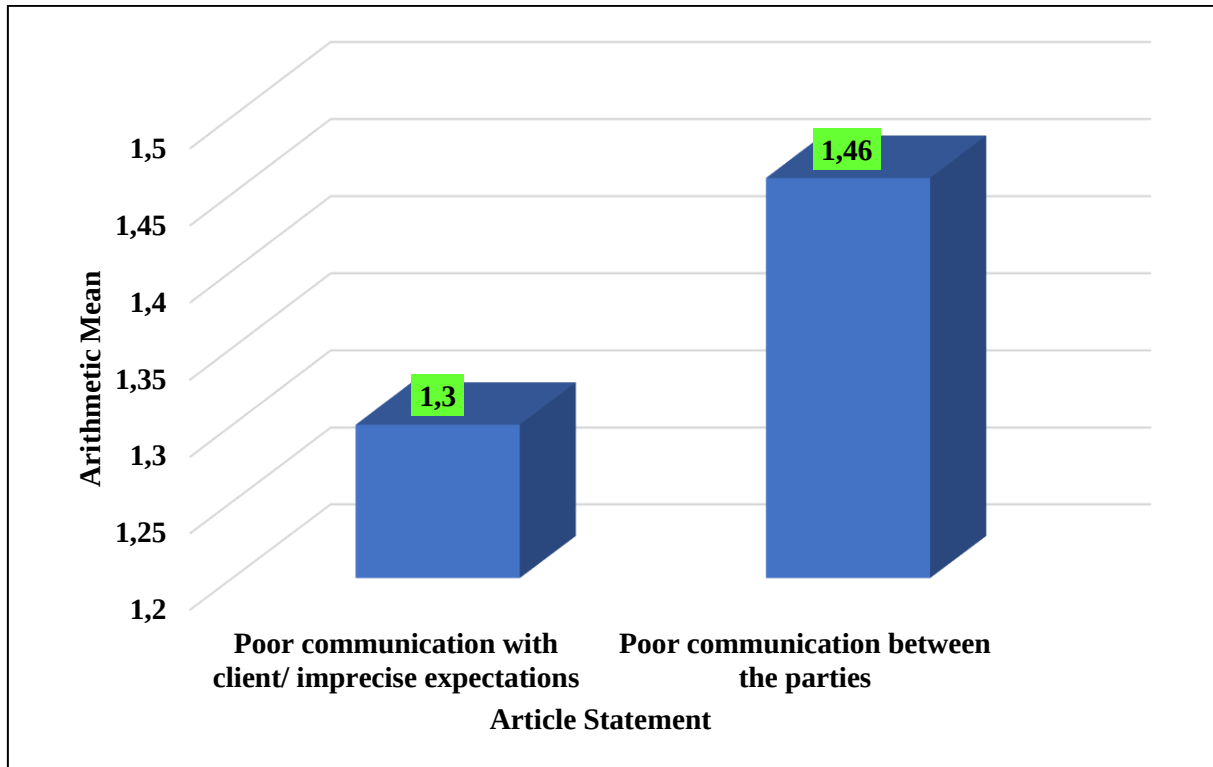


Figure 4.12: Graphical Representation of Arithmetic Mean of The Communication Risks.

The statistical analysis results showed the average and standard deviation for every one of the Communication Risks sub-factors. These factors are arranged in descending order. See table (4.37).

- i. Poor communication between the parties (1.46)
- ii. Poor communication with client/ imprecise expectations (1.30)

Table 4.38 explains the results of arithmetic mean and order of the financial risks.

Table 4.38: The Results of Arithmetic Mean and Order of The Financial Risks.

Paragraph	Z value	Standard Deviation	Arithmetic Mean
Financial problems of the client	-14.079	1.087	1.47
Financial problems of the Contractor	-24.706	0.712	1.24
Delaying or refusing payments to contractors, subcontractors, or workers	-24.706	0.712	1.24
External economic factors such as (fluctuations of price and interest rates, inflation, recession)	-20.472	0.757	1.45

Figure 4.13 explains a graphical representation of arithmetic mean of the financial risks.

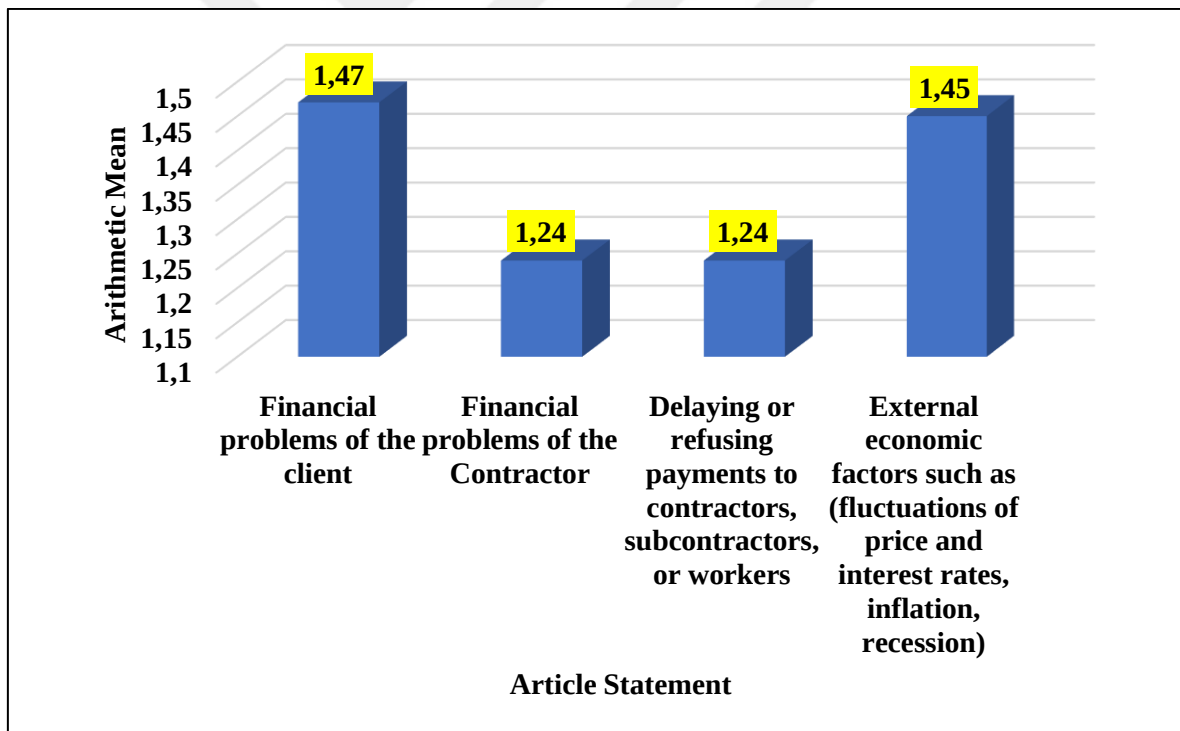


Figure 4.13: Graphical Representation of Arithmetic Mean of The Financial Risks.

The statistical analysis results showed the average and standard deviation for every one of the *Financial Risks* sub-factors. These factors are arranged in descending order. See table (4.38).

- i. Financial problems of the client (1.47)
- ii. External economic factors such as (fluctuations in price and interest rates, inflation, and recession) (1.45)
- iii. Financial problems of the Contractor (1.24)
- iv. Delaying or refusing payments to contractors, subcontractors, or workers (1.24)

Table 4.39 illustrates the results of arithmetic mean and order of the legal risks.

Table 4.39: The Results of Arithmetic Mean and Order of The Legal Risks.

Paragraph	Z value	Standard Deviation	Arithmetic Mean
Contractual weakness (weakness in the terms of the contract)	-19.902	0.759	1.49
Inconsistencies and mistakes in the contract documents	-14.357	1.059	1.48
Terrorism and sabotage	-14.357	1.059	1.48
Changes in applicable law during project implementation	-5.149	1.515	2.22

Figure 4.14 represents a graphical representation of arithmetic mean of the legal risks.

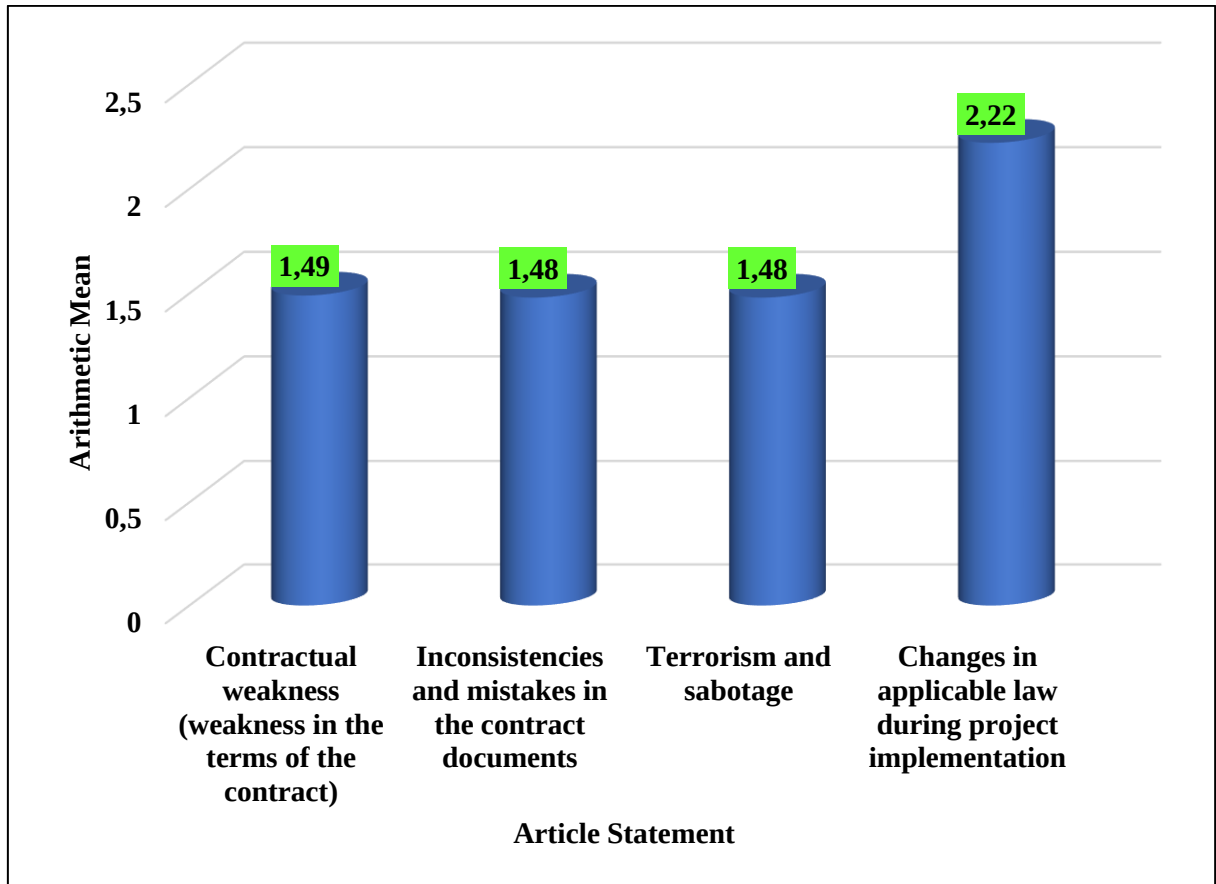


Figure 4.14: Graphical Representation of Arithmetic Mean of The Legal Risks.

The results of the statistical analysis showed the average and standard deviation for every one of the Legal Risks sub-factors. These factors are arranged in descending order. See table (4.39).

- i. Changes in applicable law during project implementation (2.22)
- ii. Contractual weakness (weakness in terms of the contract) (1.49)
- iii. Inconsistencies and mistakes in the contract documents (1.48)
- iv. Terrorism and sabotage (1.48)

Table 4.40 presents the results of arithmetic mean and order of the market risks.

Table 4.40: The Results of Arithmetic Mean and Order of The Market Risks.

Paragraph	Z value	Standard Deviation	Arithmetic Mean
Poor transportation and logistics performance	-2.787	1.471	2.59
Lowest bidding procurement method	-9.029	1.362	1.77
Delays in the delivery of materials	-9.029	1.362	1.77

Figure 4.15 shows a graphical representation of arithmetic mean of the market risks.

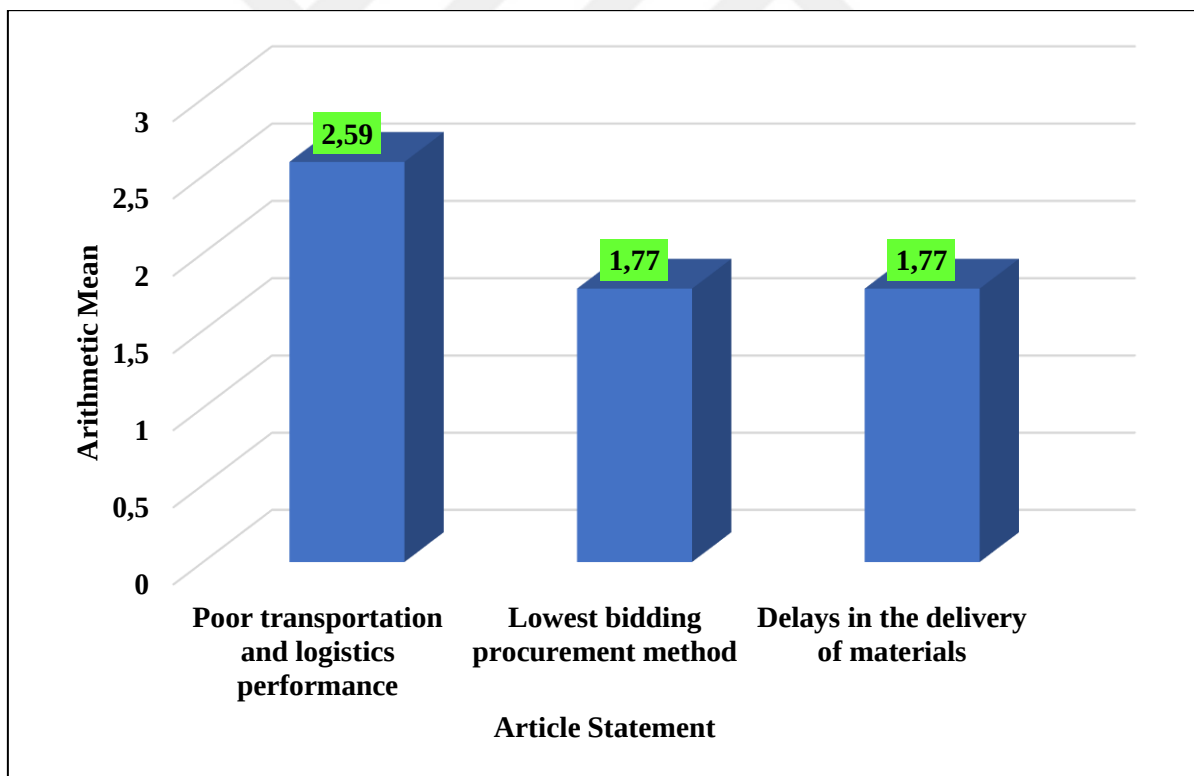


Figure 4.15: Graphical Representation of Arithmetic Mean of The Market Risks.

The statistical analysis results showed the average and standard deviation for every one of the Market Risk sub-factors. These factors are arranged in descending order. See table (4.40).

- i. Poor transportation and logistics performance (2.59)
- ii. Lowest bidding procurement method (1.77)
- iii. Delays in the delivery of materials (1.77)

Table 4.41 shows the results of arithmetic mean and order of the policy and political risks.

Table 4.41: The Results of Arithmetic Mean and Order of The Policy and Political Risks.

Paragraph	Z value	Standard Deviation	Arithmetic Mean
Excessive bureaucracy	-6.051	1.339	2.19
Delays due to complex political situation	-9.029	1.362	1.77

Figure 4.16 Shows Representation of Arithmetic Mean of The Policy and Political Risks.

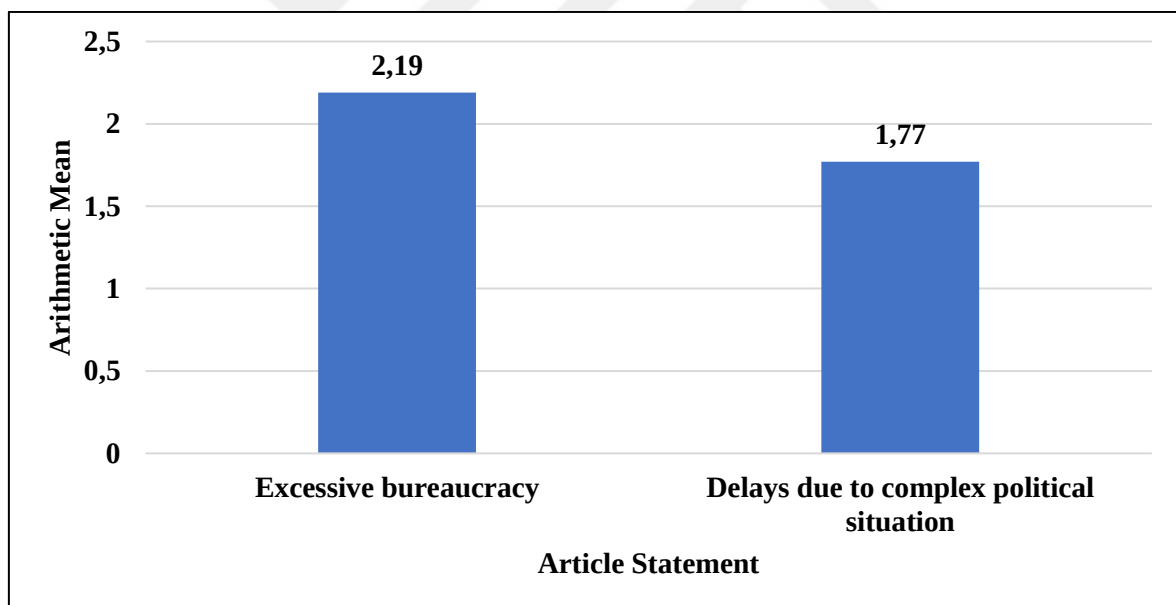


Figure 4.16: Graphical Representation of Arithmetic Mean of The Policy and Political Risks.

The statistical analysis results showed the mean and standard deviation values for each of the Policy and Politics Risks sub-factors. These factors are arranged in descending order. See Table 4.41.

- i. Excessive bureaucracy (2.19)
- ii. Delays due to complex political situation (1.77)

Table 4.42 explains the results of arithmetic mean and order of the technical risks.

Table 4.42: The Results of Arithmetic Mean and Order of The Technical Risks.

Paragraph	Z value	Standard Deviation	Arithmetic Mean
Variation works / Change order	13.127	1.150	4.51
Unforeseen ground conditions (lack of site investigations)	13.127	1.150	4.51
Time underestimation (inadequate time)	12.134	1.055	4.28

Figure 4.17 presents a graphical representation of arithmetic mean of the technical risks.

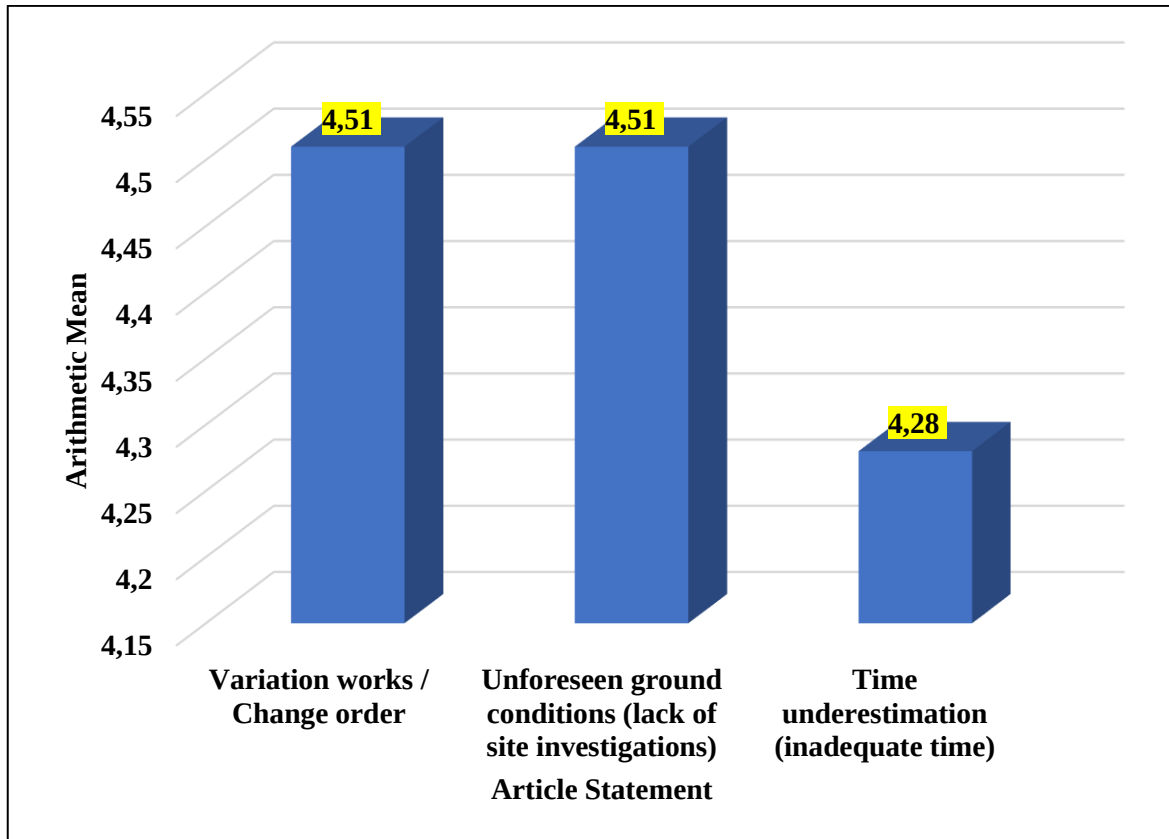


Figure 4.17: Graphical Representation of Arithmetic Mean of the Technical Risks.

The statistical analysis results showed the average and standard deviation for every one of the Technical Risks sub-factors. These factors are arranged in descending order. See table (4.34).

- i. Variation works / Change order (4.51)
- ii. Unforeseen ground conditions (lack of site investigations) (4.51)
- iii. Time underestimation (inadequate time) (4.28)

Table 4.43 indicates the results of arithmetic mean and order of the design risks.

Table 4.43: The Results of Arithmetic Mean and Order of The Design Risks.

Paragraph	Z value	Standard Deviation	Arithmetic Mean
Errors in design or changes	11.849	1.190	4.41
Design and drawing flaws	9.573	1.368	4.31
Inadequate architecture design	9.573	1.368	4.31

Figure 4.18 presents a graphical representation of arithmetic mean of the design risks.

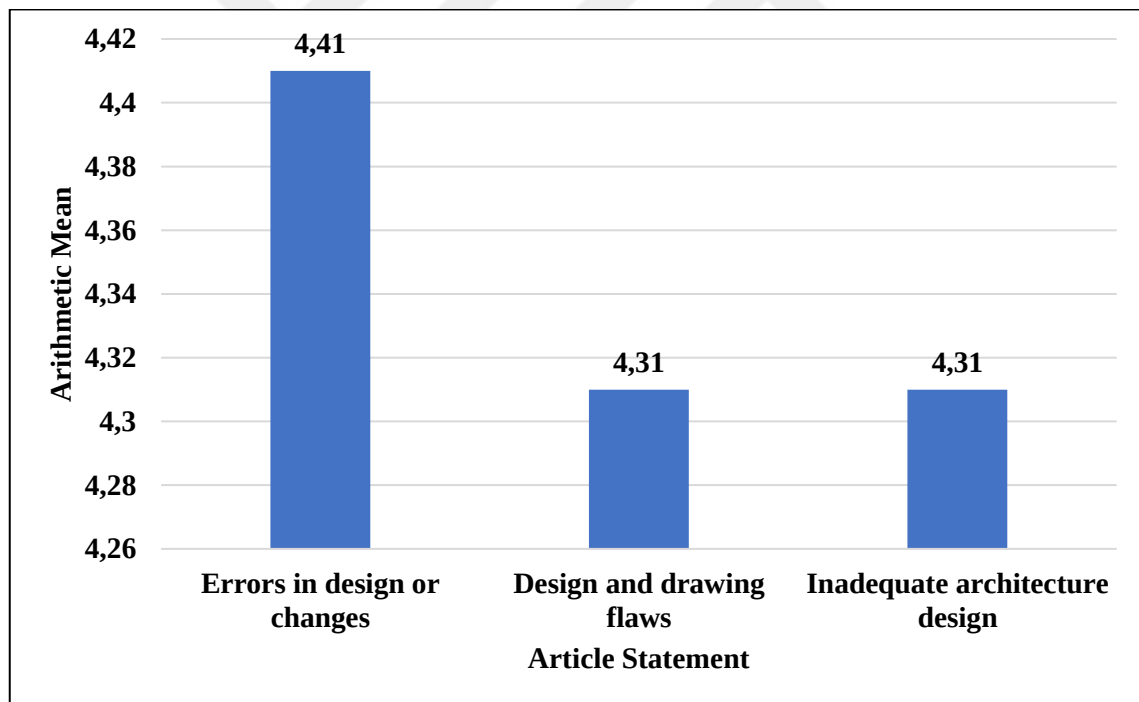


Figure 4.18: Graphical Representation of Arithmetic Mean of the Design Risks.

The statistical analysis results showed the average and standard deviation for every one of the Design Risks sub-factors. These factors are arranged in descending order. See Table (4.43).

- i. Errors in design or changes (4.41)
- ii. Design and drawing flaws (4.31)
- iii. Inadequate architecture design (4.31)

Table 4.44 indicates the results of arithmetic mean and order of the human resources risks.

Table 4.44: The Results of Arithmetic Mean and Order of The Human Resources Risks.

<i>Paragraph</i>	<i>Z value</i>	<i>Standard Deviation</i>	<i>Arithmetic Mean</i>
Insufficient number/ lack of workers	12.934	1.082	4.40
Insufficient number/lack of qualified personnel	12.403	1.097	4.36

Figure 4.19 illustrates a graphical representation of arithmetic mean of the human resources risks.

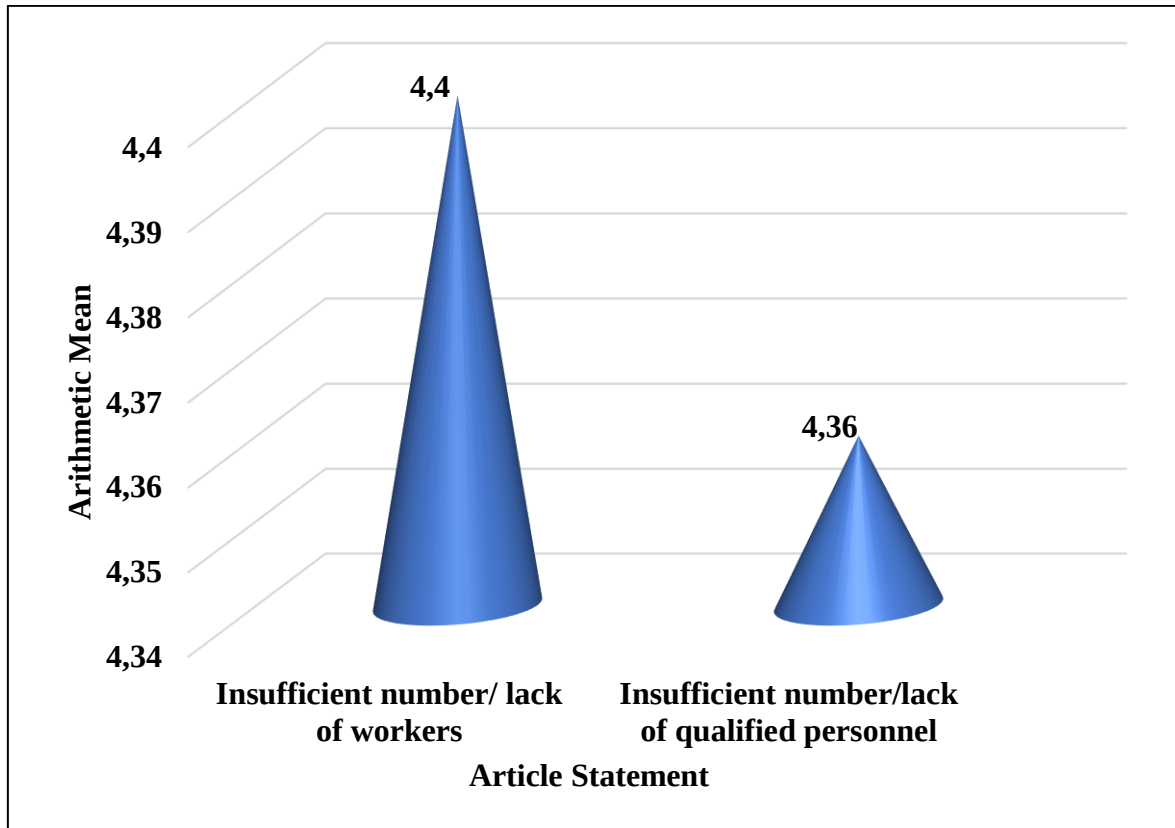


Figure 4.19: Graphical Representation of Arithmetic Mean of The Human Resources Risks.

The statistical analysis results showed the average and standard deviation for every one of the Human Resources Risks sub-factors. These factors are arranged in descending order. See Table (4.44).

- i. Insufficient number/ lack of workers (4.40)
- ii. Insufficient number/lack of qualified personnel (4.36)

Table 4.45 indicates the results of arithmetic mean and order of the quality mismanagement risks.

Table 4.45: The Results of Arithmetic Mean and Order of The Quality Mismanagement Risks.

Paragraph	Z value	Standard Deviation	Arithmetic Mean
Reworks due to poor quality or flaws in execution	-5.926	1.620	2.04
Poor quality or damage of building materials	-5.679	1.602	2.09

Figure 4.20 presents a graphical representation of arithmetic mean of the quality mismanagement risks.

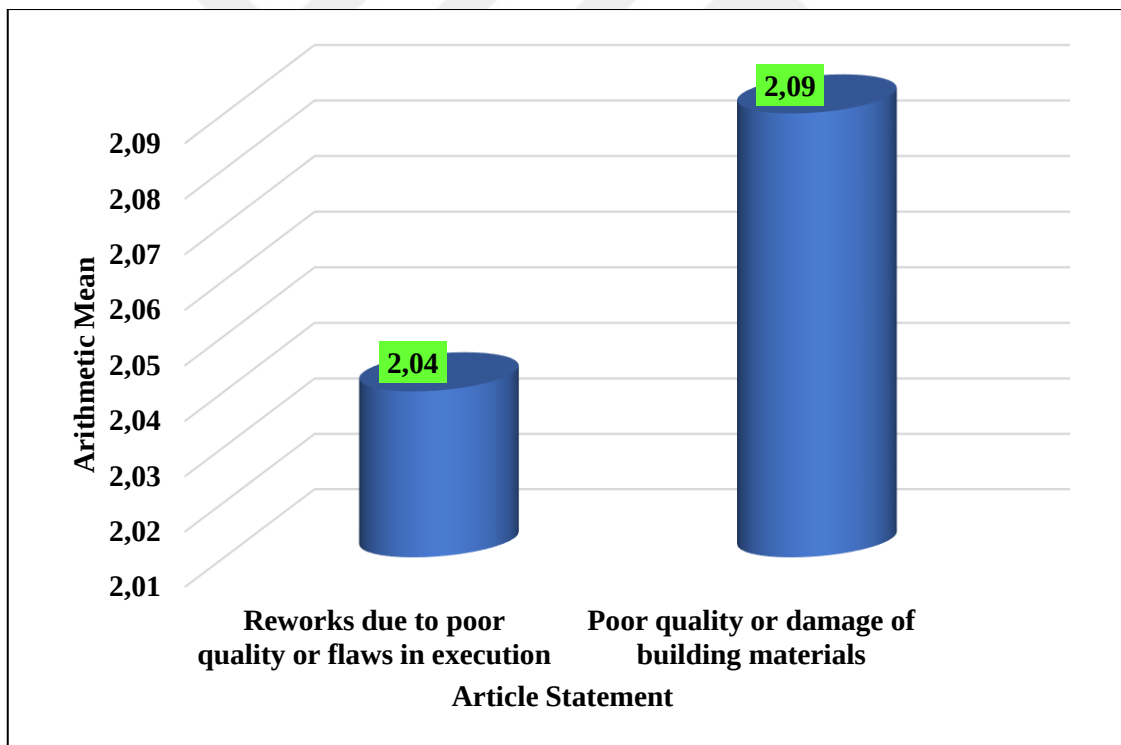


Figure 4.20: Graphical Representation of Arithmetic Mean of The Quality Mismanagement Risks.

The statistical analysis results showed the mean and standard deviation values for each of the Risks in Mismanagement Quality sub-factors. These factors are arranged in descending order. See table (4.45).

- i. Poor quality or damage of building materials (2.09)
- ii. Reworks due to poor quality or flaws in execution (2.04)

Table 4.46 presents the results of arithmetic mean and order of the safety risks.

Table 4.46: The Results of Arithmetic Mean and Order of The Safety Risks.

Paragraph	Z value	Standard Deviation	Arithmetic Mean
Lack of safety in construction	-4.941	1.538	2.24
Delays due to incompetence, or lack of experience of workers	-5.187	1.562	2.19
Random events (e.g., accidents)	-4.505	1.554	2.30

Figure 4.21 represents a graphical representation of arithmetic mean of the safety risks.

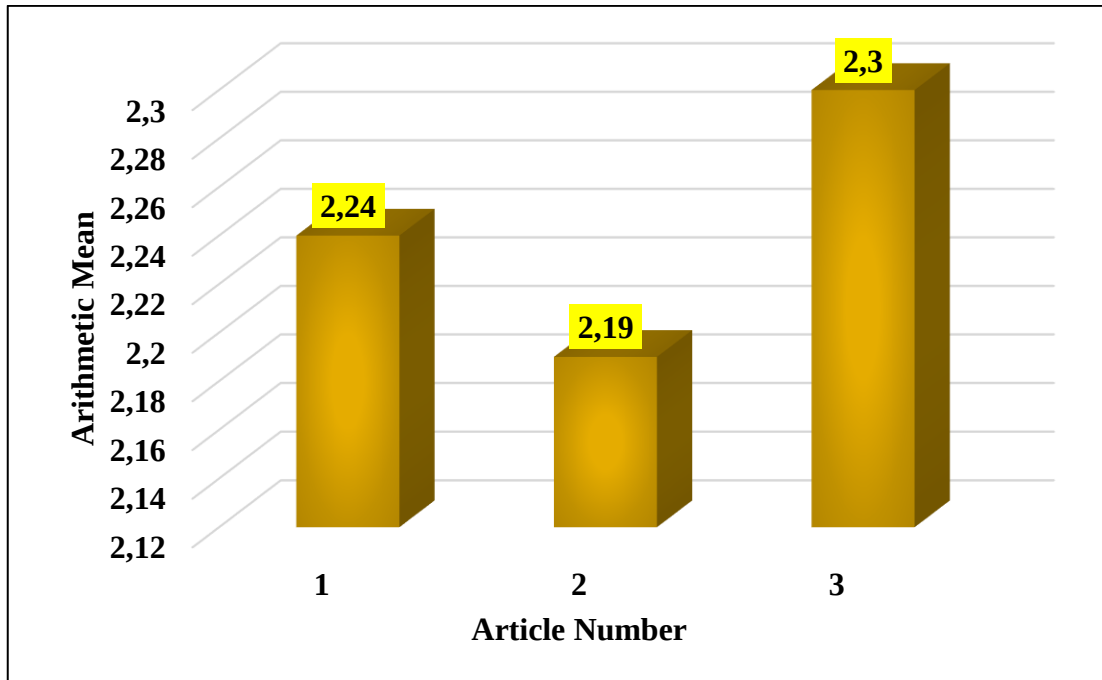


Figure 4.21: Graphical Representation of Arithmetic Mean of the Safety Risks.

The statistical analysis results showed the average and standard deviation for every one of the **Safety Risks** sub-factors. These factors are arranged in descending order. See table (4.46).

- i. Random events (e.g., accidents) (2.30)
- ii. Lack of safety in construction (2.24)
- iii. Delays due to incompetence or lack of experience of workers (2.19)

Table 4.47 represents the results of arithmetic mean and order of the health risks.

Table 4.47: The Results of Arithmetic Mean and Order of The Health Risks.

Paragraph	Z value	Standard Deviation	Arithmetic Mean
Illness or death of workers	-4.505	1.554	2.30
Low productivity of the workers (poor working conditions, low morale)	2.652	1.584	3.42
Bad weather or climatic conditions	6.429	1.120	3.72

Figure 4.22 illustrates a graphical representation of arithmetic mean of the health risks.

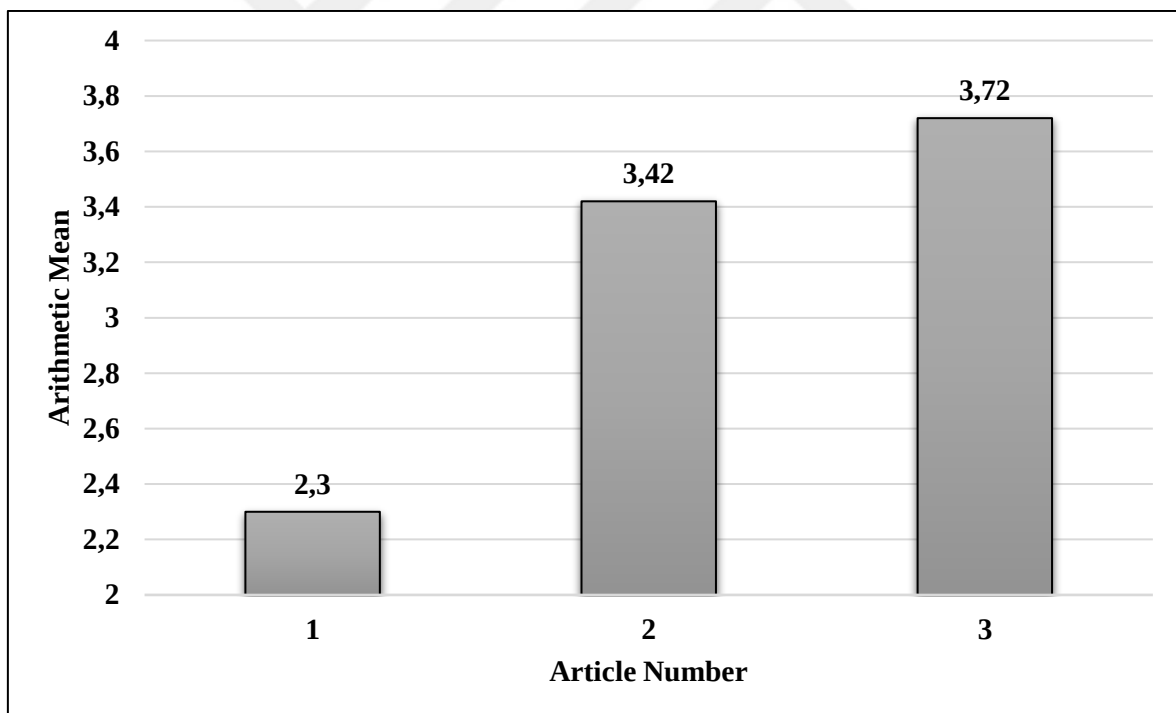


Figure 4.22: Graphical Representation of Arithmetic Mean of The Health Risks.

The statistical analysis results showed the average and standard deviation for every one of the Health Risks sub-factors. These factors are arranged in descending order. See table (4.47).

- i. Bad weather or climatic conditions (3.72).
- ii. Low productivity of the workers (poor working conditions, low morale) (3.42).
- iii. Illness or death of workers (2.30).

4.3.5 Cronbach's Alpha Coefficient

The internal consistency of statistical tests, including questionnaires and similar initiatives, is measured by the Cronbach's alpha coefficient. The degree to which a set of things is related to one another as a coherent set is known as internal consistency or reliability.

The fundamental guideline for evaluating Cronbach's alpha scale for questions using the Likert scale or dichotomous questions (i.e., questions with two alternative answers) are [90]:

Table 4.48: The Cronbach's Alpha Coefficient Levels.

<i>Paragraph</i>	<i>Result</i>
$\alpha < 0.50$	Not Acceptable
$0.50 \leq \alpha < 0.60$	Poor
$0.60 \leq \alpha < 0.70$	Questionable
$0.70 \leq \alpha < 0.80$	Acceptable
$0.80 \leq \alpha < 0.90$	Good
$0.90 \leq \alpha$	Excellent

Table 4.49 illustrates the reliability statistics for the groups.

Table 4.49: Reliability Statistics For The Groups.

No. of Group	Cronbach's Alpha
Group 1	0.698
Group 2	0.983
Group 3	0.920
Group 4	0.938
Group 5	0.821
Group 6	0.750
Group 7	0.928
Group 8	0.743
Group 9	0.805
Group 10	0.881
Group 11	0.995
Group 12	0.935
Group 13	0.752

The study's findings indicate that the questionnaire is trustworthy on the scale based on the aforementioned reference because the alpha Cronbach coefficient value ranges from (0.698 to 0.995). The alpha coefficient for each questionnaire group is also shown in Table 4.49. A graphic representation of the groups' reliability data is shown in Figure 4.23.

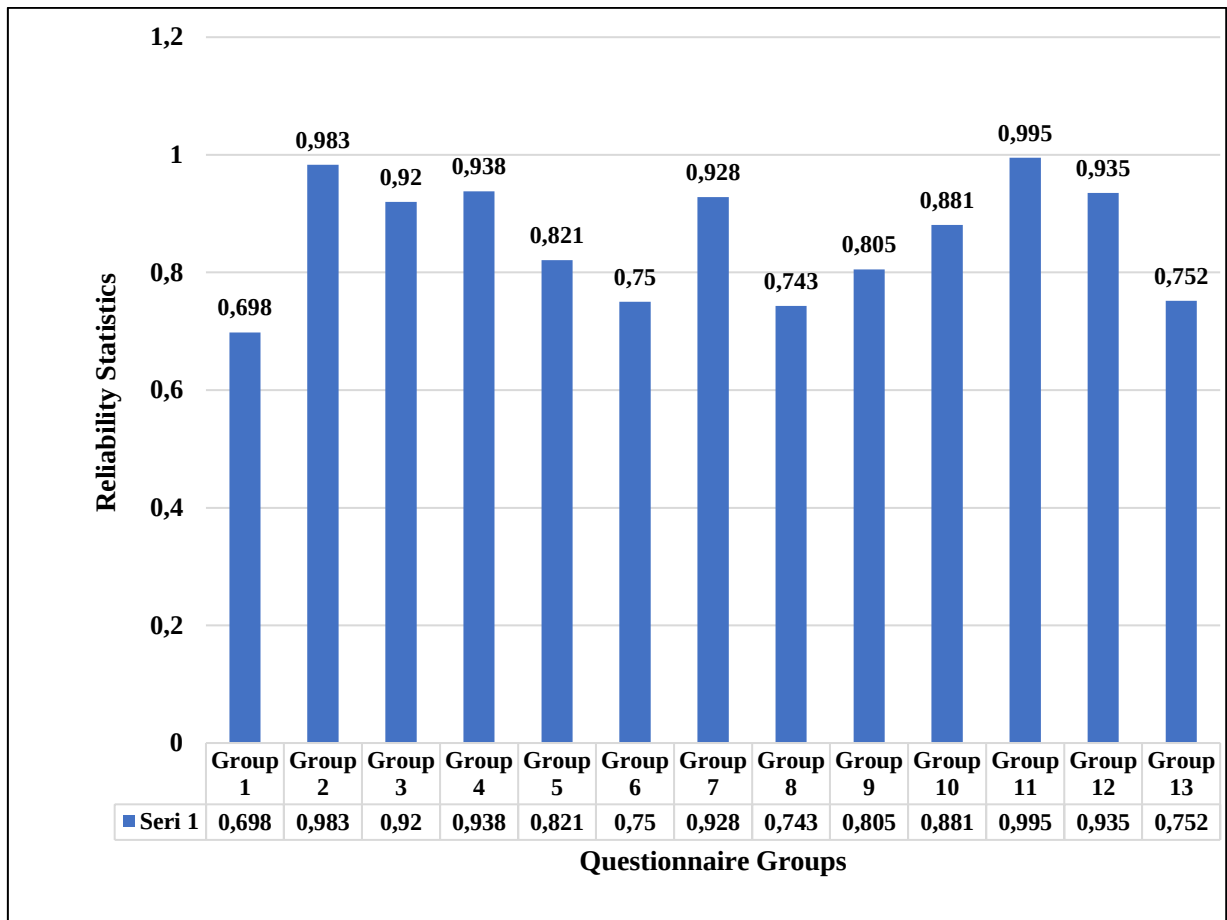


Figure 4.23: Graphical representation of reliability statistics for the groups.

Through the values of Cronbach's alpha coefficient appearing in the previous table, we notice from Figure 4.23 that the values of the alpha Cronbach's coefficient resulting from the statistical analysis process fall within the acceptance region, which indicates that the questionnaire is good. Therefore, the scale based on the previous reference can be adopted.

Table 4.50 indicates the Cronbach's Alpha statistics for the groups.

Table 4.50: Cronbach's Alpha Statistics for The Groups.

No. of Group	Cronbach's Alpha
13	0.948

The study results show that a reliability coefficient (0.948) was calculated for this research, indicating a high level of reliability.

4.4 REVIT SOFTWARE NUMERICAL QUANTITY-TAKE-OFF RESULTS

Table 4.51 represents the results of a comparative analysis between the REVIT software and the manual method to estimate the excavation, blinding and ground slab components of the construction project investigated in the case study.

Table 4.51: The Results of A Comparative Analysis Between The REVIT Software and The Manual Method to Estimate The Excavation, Blinding and Ground Slab Components of The Construction Project.

Comparison		Manual (m ³)	REVIT (m ³)	Ratio (Rev./ Man.) *100
Excavation		16776.58	16643.83	99.21 %
Blinding		126.40	125.54	99.32 %
Ground Slab Component	INS. MAT.	11.56	11.56	100.00 %
	P.C	57.82	57.80	99.97 %
	CRU. STO.	173.46	173.39	99.96 %

Also, Table 4.52 represents the comparative analysis between the REVIT software and the manual method to estimate the reinforcement concrete.

Table 4.52: The Results of The Comparative Analysis Between The REVIT Software and The Manual Method to Estimate The Reinforcement Concrete Amount of The Construction Project.

Comparison	Manual (m ³)	REVIT (m ³)	Ratio (Rev./ Man.) *100
Footing	349.11	346.74	99.32 %
Ground slab	115.64	115.59	99.96 %
Walls and Columns	727.10	721.18	99.19 %
Slabs and Beams	1099.39	1085.32	98.72 %

Moreover, the results of the comparative analysis between the REVIT software and the manual method to estimate the reinforcement steel amount of the construction project are presented in Table 4.53.

Table 4.53: The Results of The Comparative Analysis Between The REVIT Software and The Manual Method to Estimate The Reinforcement Steel Amount of The Construction Project.

Comparison	Manual (ton)	REVIT (ton)	Ratio (Rev./ Man.) *100
Footing	27.191	26.494	97.44 %
Columns	69.804	67.921	97.30 %
Walls	56.533	55.214	97.67 %
Beams	162.958	156.544	96.06 %
Slabs	63.640	59.561	93.59 %
Stair Case	4.551	4.258	93.56 %

It can be concluded from the results shown in Tables 4.51, 4.52, and 4.53 that this research has verified the effectiveness of using quantity surveying for construction works based on

the use of BIM technology tools in implementation, increasing performance efficiency, professionalism, accuracy and speed of outputs to up-to-date with technological development. Through the results, it was shown the convergence of values between the traditional methods of the quantity survey and using BIM applications. In addition, it was found that using BIM technology and numerical REVIT quantity take-off is more accurate, has fewer human mistakes and is faster in obtaining results. These results affect the construction project in all aspects.

Figure 4.24 Depicts A Graphical Representation of REVIT Results Regarding The Reinforcement Steel Calculations of The Construction Project.

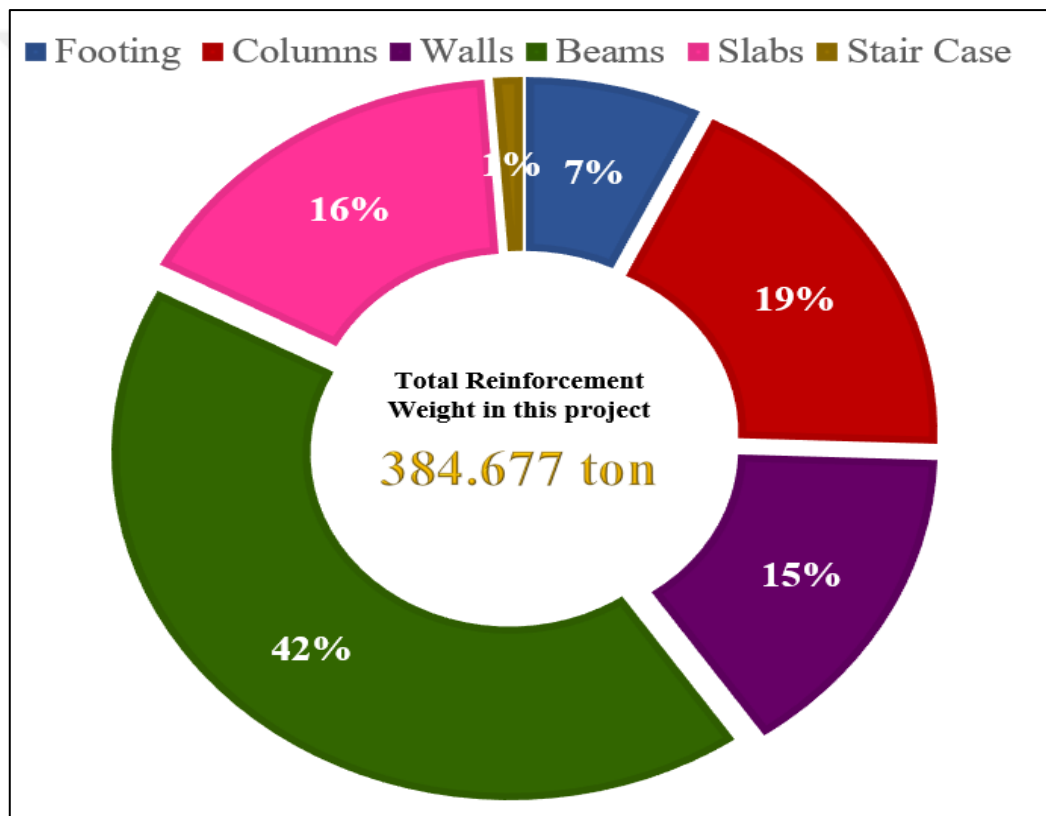


Figure 4.24: Graphical Representation of REVIT Results Regarding The Reinforcement Steel Calculations of The Construction Project.

5. CONCLUSIONS AND RECOMMENDATIONS

5.1 INTRODUCTION

This chapter presents the conclusions and recommendations of the research based on the importance of losses resulting from exceeding the specified time for completion and its impact on the status of the project and delay in utilizing services. It identifies the most prominent factors that affect the research by determining the degree of importance of each element of the study.

5.2 CONCLUSIONS

The researcher conducted a survey aimed at identifying the factors affecting losses resulting from exceeding the specified time for completion and its impact on the status of the project and delay in utilizing services by designing a questionnaire and distributing it using a Google model to a group of specialists in engineering projects and evaluating the most prominent factors in terms of the degree of importance and their impact on the construction and contracting sector.

The researcher reached some conclusions:

- a. The study results showed that the most important basic elements that affect the implementation of projects and are among the reasons for delaying projects are cost, quality, and time.
- b. The results indicated that using the numerical REVIT quantity take-off to calculate the cost, schedule, and amount of construction materials provided significant levels of time, effort, and cost reduction for engineers.
- c. The study concluded that the executing companies are a major reason for the delay in the implementation of projects.
- d. The study confirmed that there are risks that affect the delay in the implementation of projects, and these risks were summarized according to the analysis of the questionnaire as follows:
 - i. Construction Mismanagement Risks.

- ii. Communication Risks.
 - iii. Financial Risks.
 - iv. Legal Risks.
 - v. Market Risks.
 - vi. Policy and Politics Risks.
 - vii. Technical Risks.
 - viii. Design Risks.
 - ix. Human Resources Risks.
 - x. Risks in Mismanagement Quality.
 - xi. Safety Risks.
 - xii. Health Risks.
- e. The study confirmed that the delay in making project decisions is a risk affecting construction mismanagement.
 - f. The study concluded that the lack of planning and management and the lack of clarity in the scope or changes in the scope and cost of the project affect construction management.
 - g. The study results showed that the risks of communication, including poor communication between the parties to the project, lead to delays in the implementation of the project's work.
 - h. The results of the study indicated that the client's financial problems lead to delays in the implementation of the project's work and are considered one of the main reasons that lead to the occurrence of risks in the delay.

5.3 RECOMMENDATIONS

The researcher recommends some recommendations to address the problems, which are:

- a. The necessity of activating the bidding procurement method is to ensure that there is no delay in the delivery of materials.

- b. Preparing and developing programs that contribute to improving the losses resulting from exceeding the specified time for completion and its impact on the project status and delay in utilizing services.
- c. Preparing more studies on the losses resulting from exceeding the specified time for completion and its impact on the status of the project and delay in utilizing services.
- d. The necessity of teaching the losses resulting from exceeding the specified time for completion and its impact on the status of the project and delay in utilizing services.
- e. The necessity of reworking due to poor quality or defects in implementation to avoid delays in the performance of projects.
- f. Improving the efficiency and experience of workers to prevent the occurrence of risks that lead to delays in construction projects.

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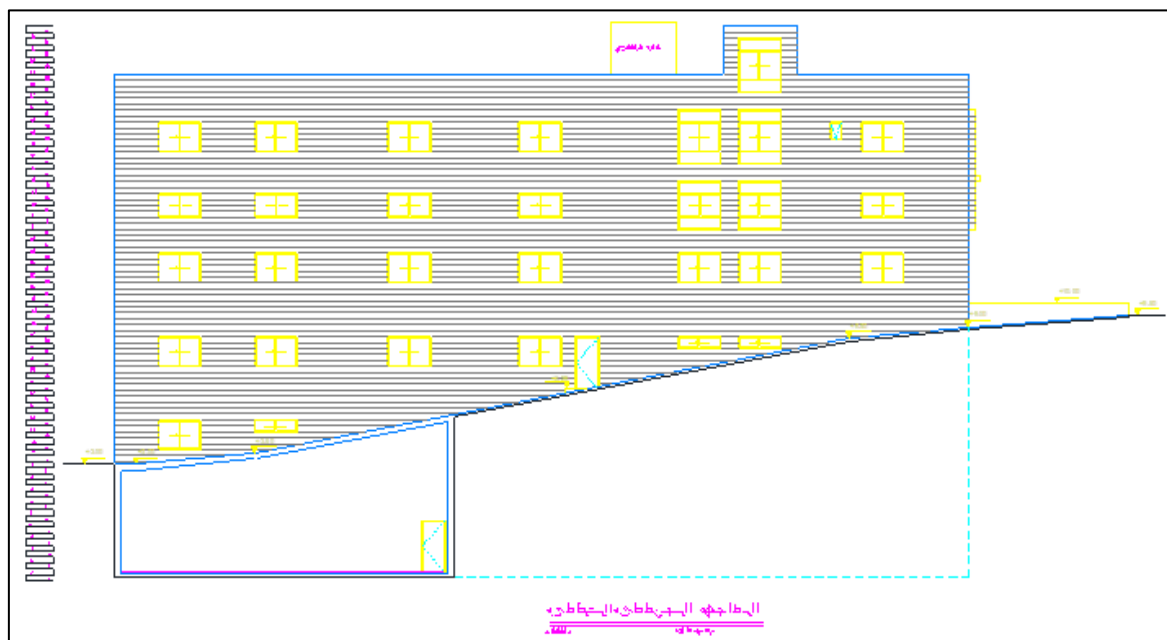
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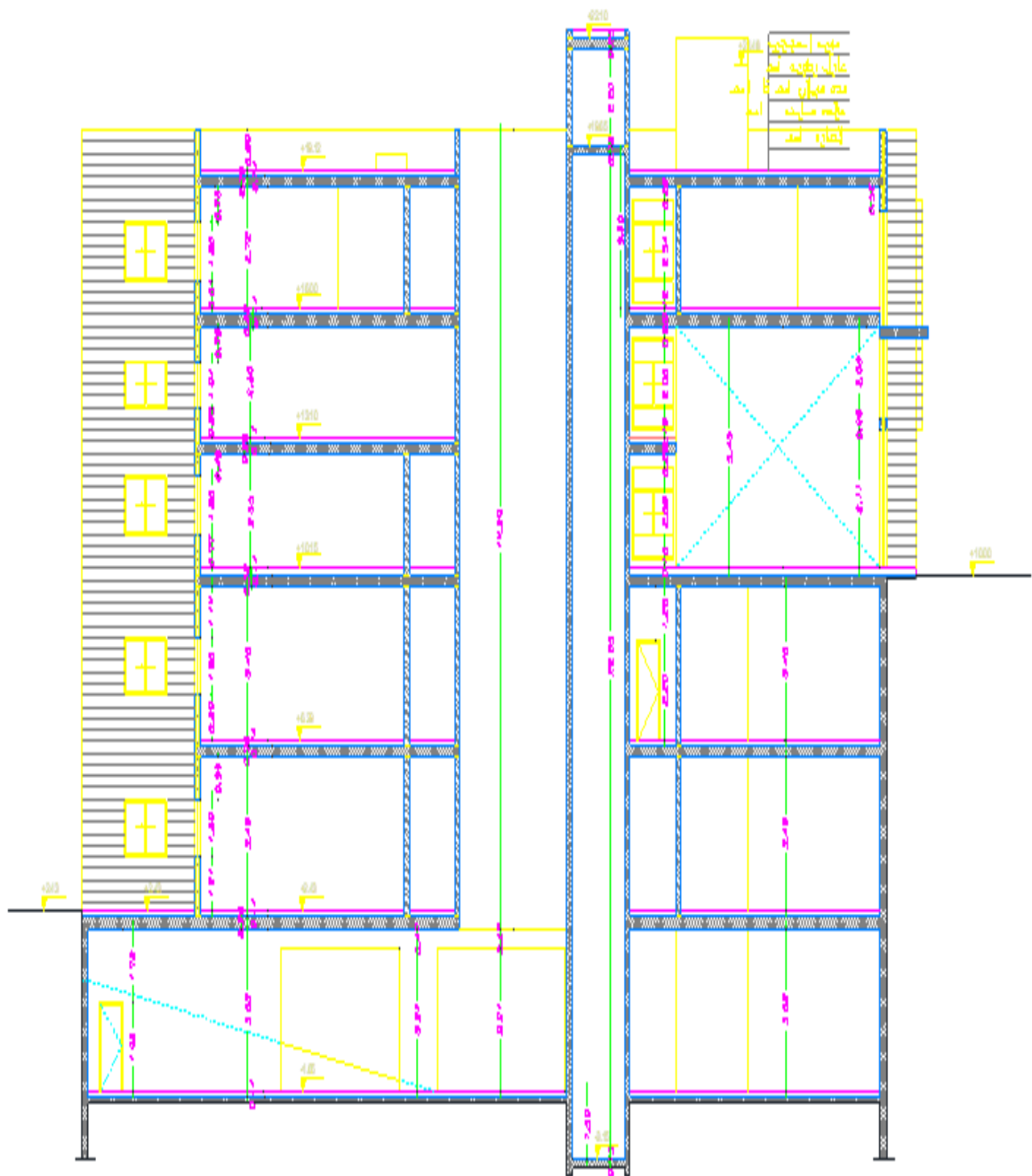
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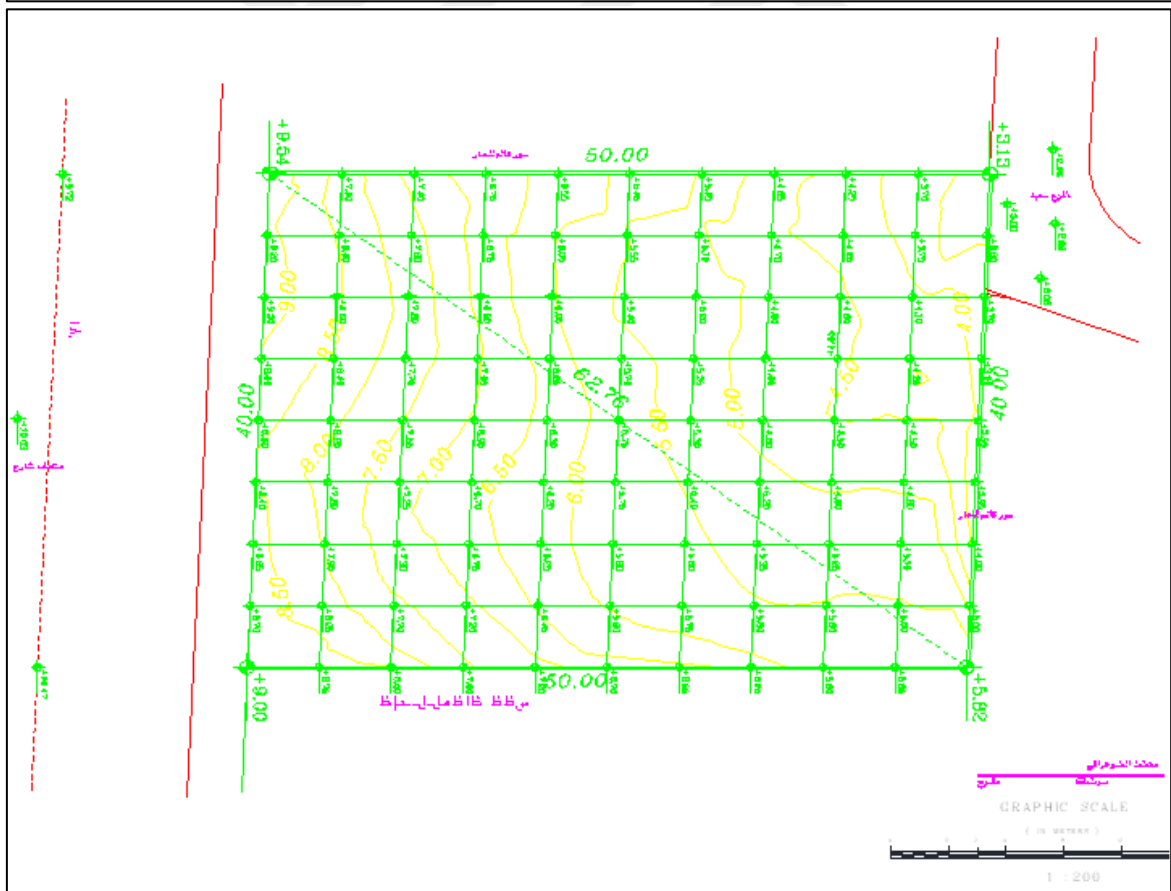
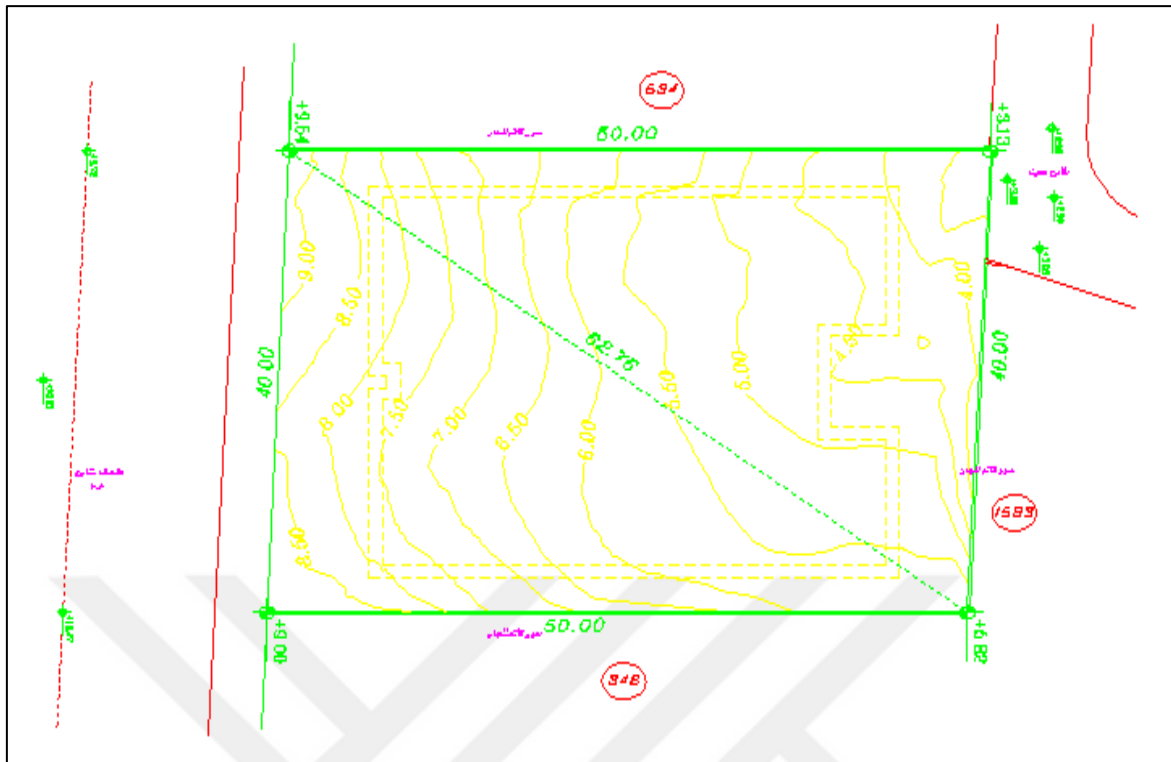
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APPENDIX A PROJECT PLANS AND INFORMATION



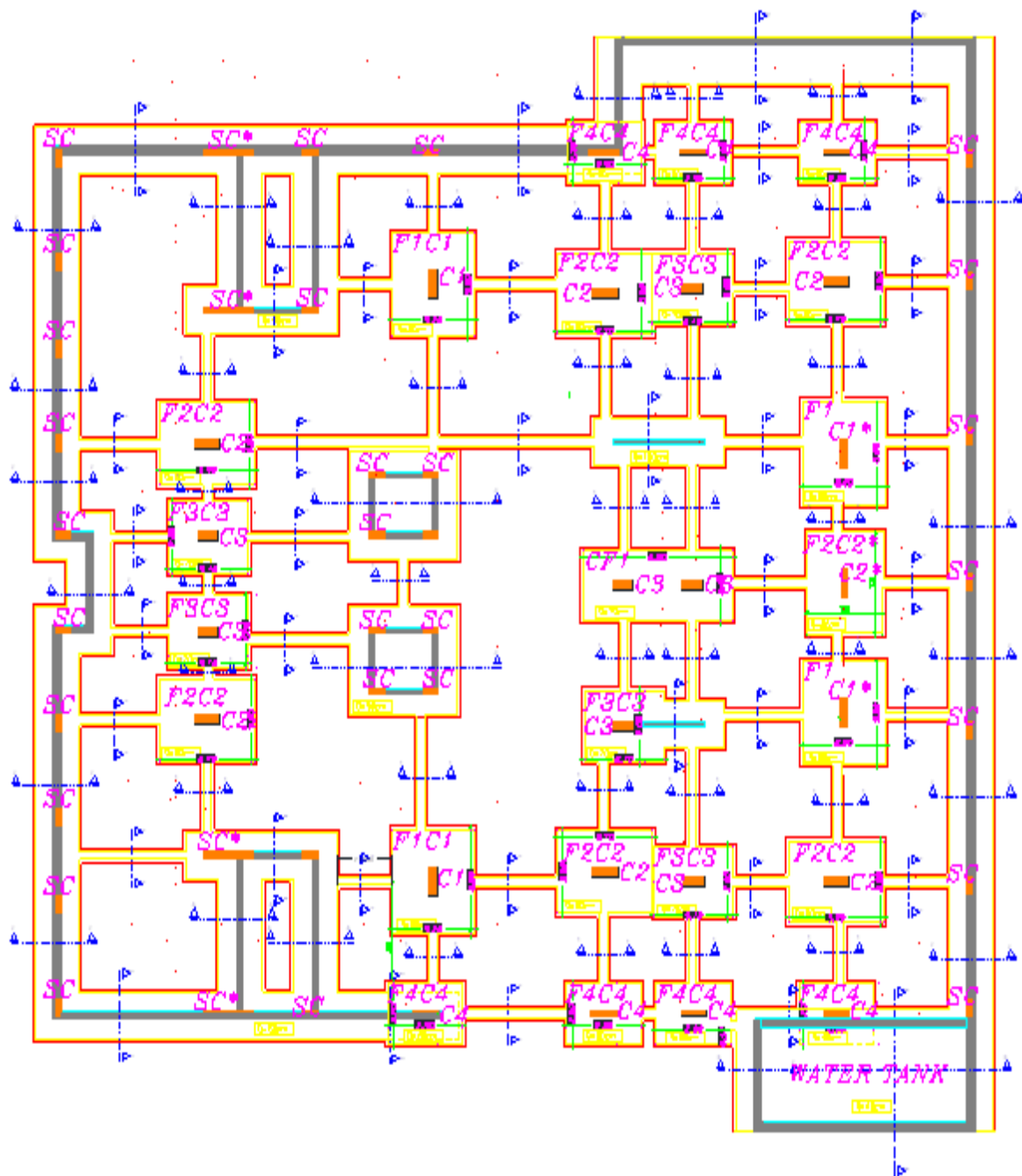






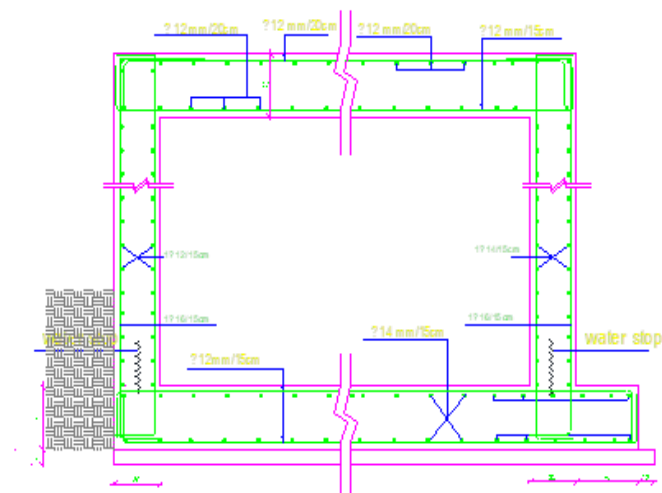
APPENDIX B

FOUNDATION CALCULATION (REINFORCED STEEL)

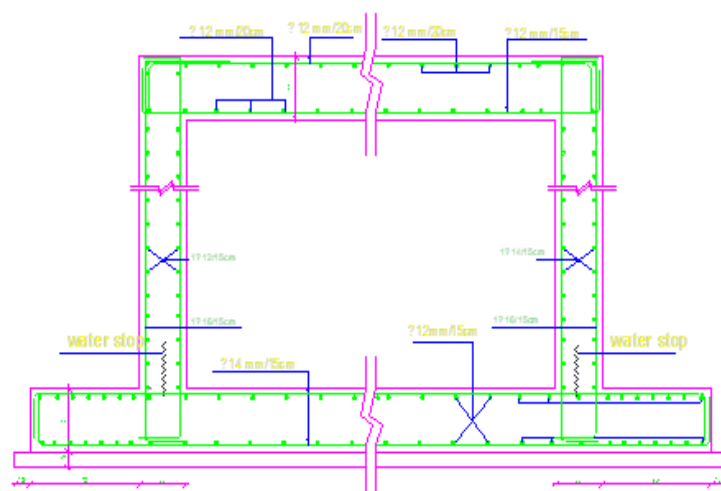


SCHEDULE OF ISOLATED FOOTINGS

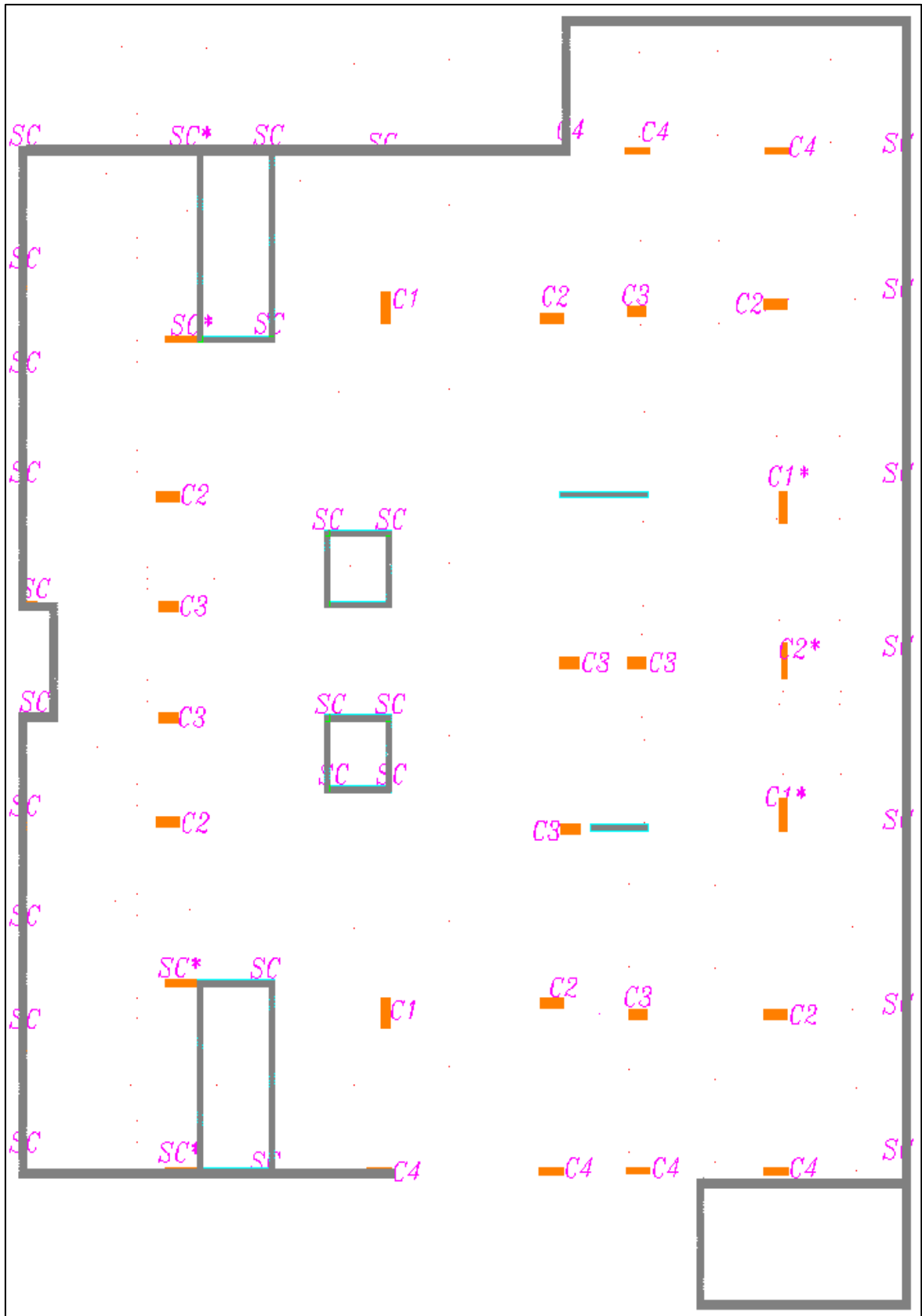
FOOTING No	CONCRETE DIMENSIONS (cm)			REINFORCEMENT			
	REINF. CONCRETE			LONG REINF.		SHORT REINF.	
	LENGTH L (cm)	WIDTH B (cm)	THICK H (cm)	NUM-DIA	TOP	NUM-DIA	TOP
F1	380	320	80	23 ϕ 20	—	20 ϕ 20	—
F2	370	300	80	25 ϕ 18	—	20 ϕ 18	—
F3	310	260	70	18 ϕ 18	—	15 ϕ 18	—
F4	290	220	60	18 ϕ 16	—	16 ϕ 16	—
CF1	580	260	70	38 ϕ 18	20 ϕ 18	18 ϕ 18	10 ϕ 18

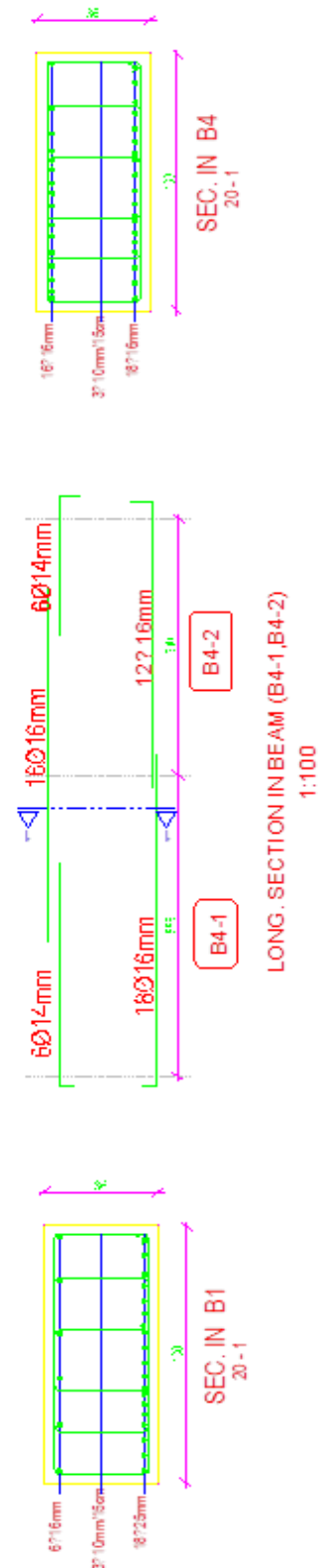
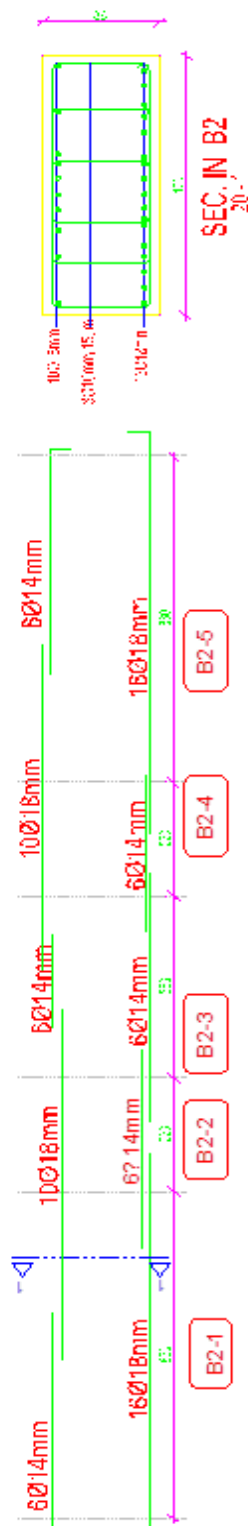


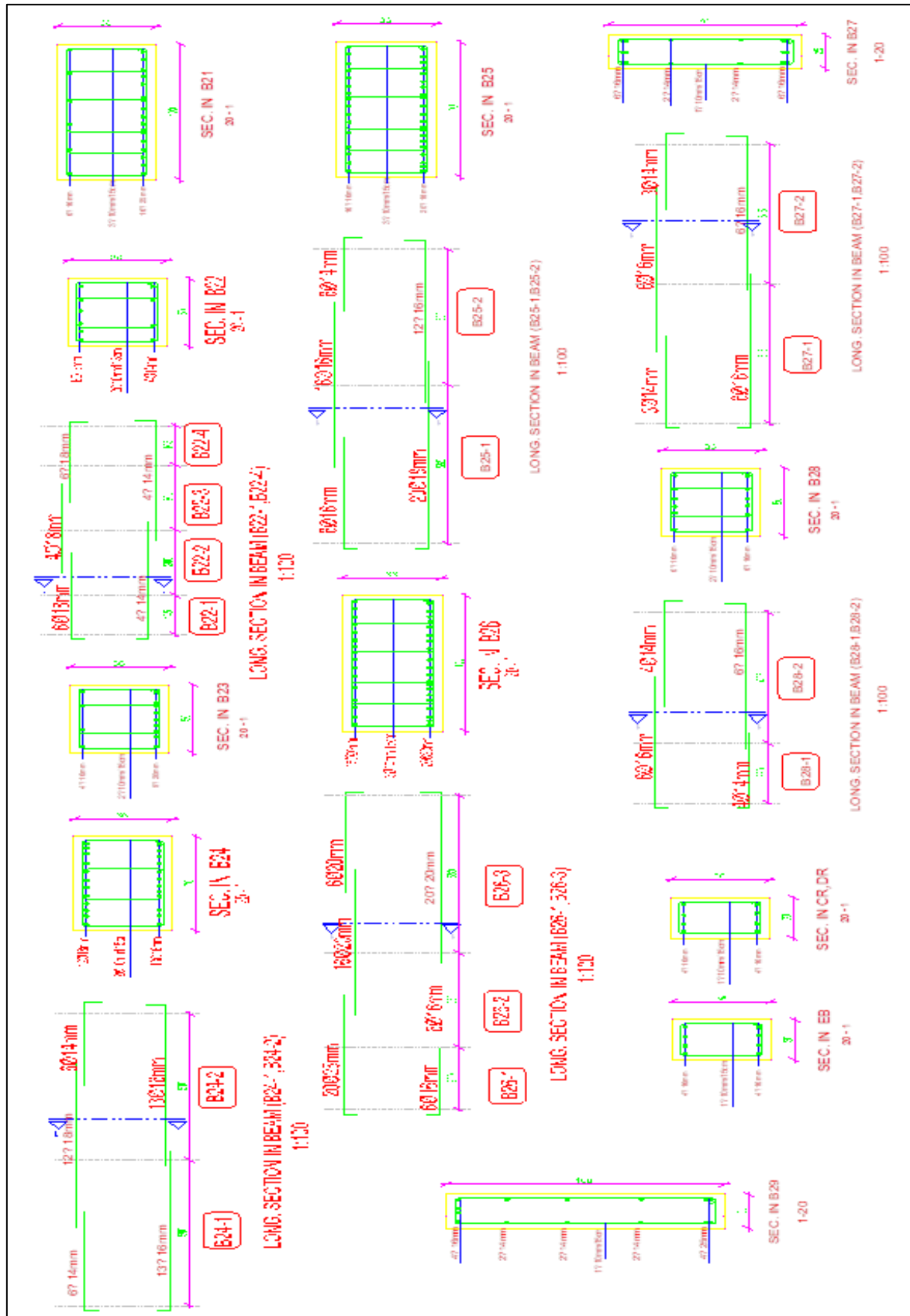
SEC 5-5 IN WATER TANK

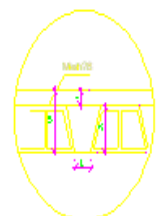
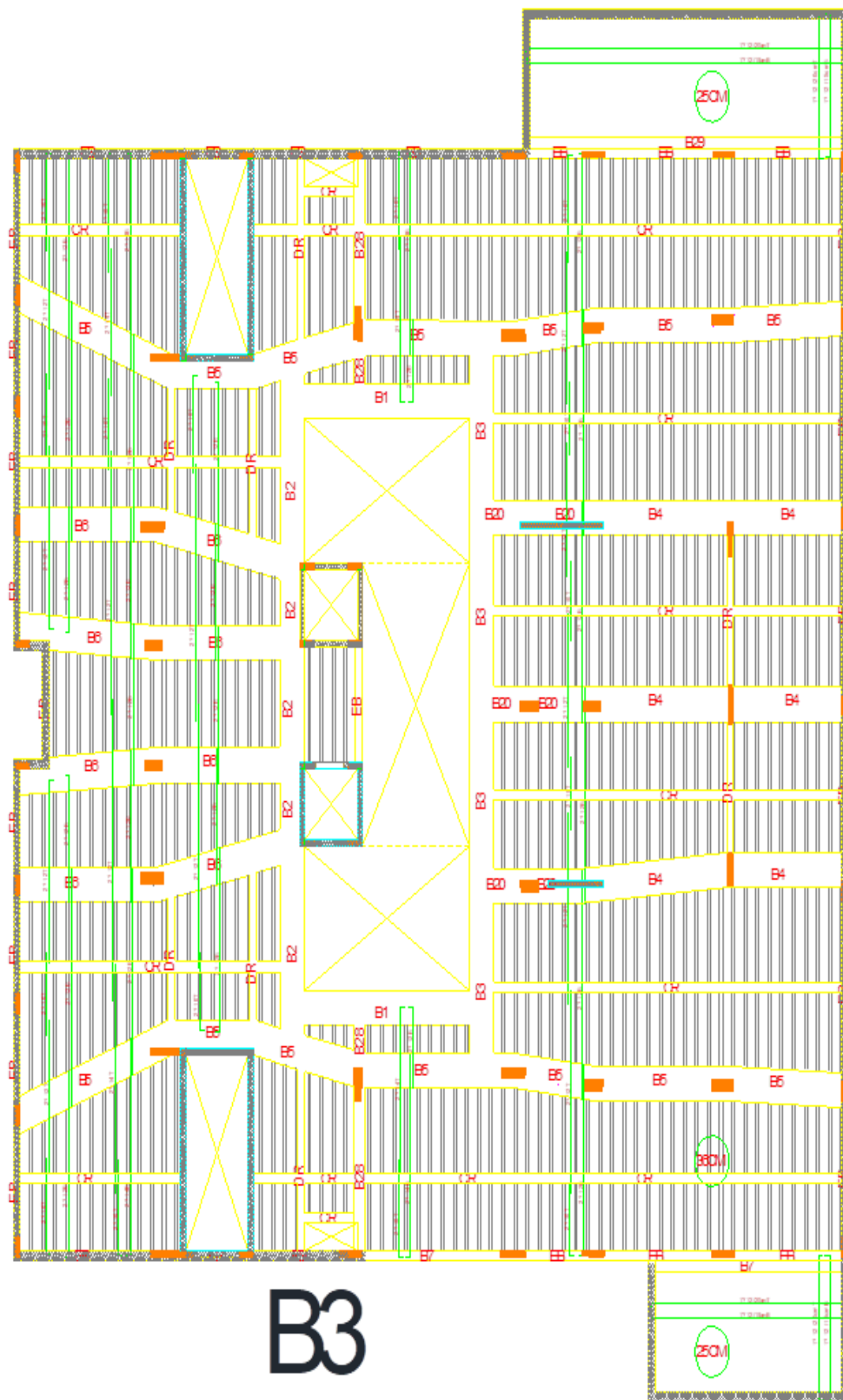


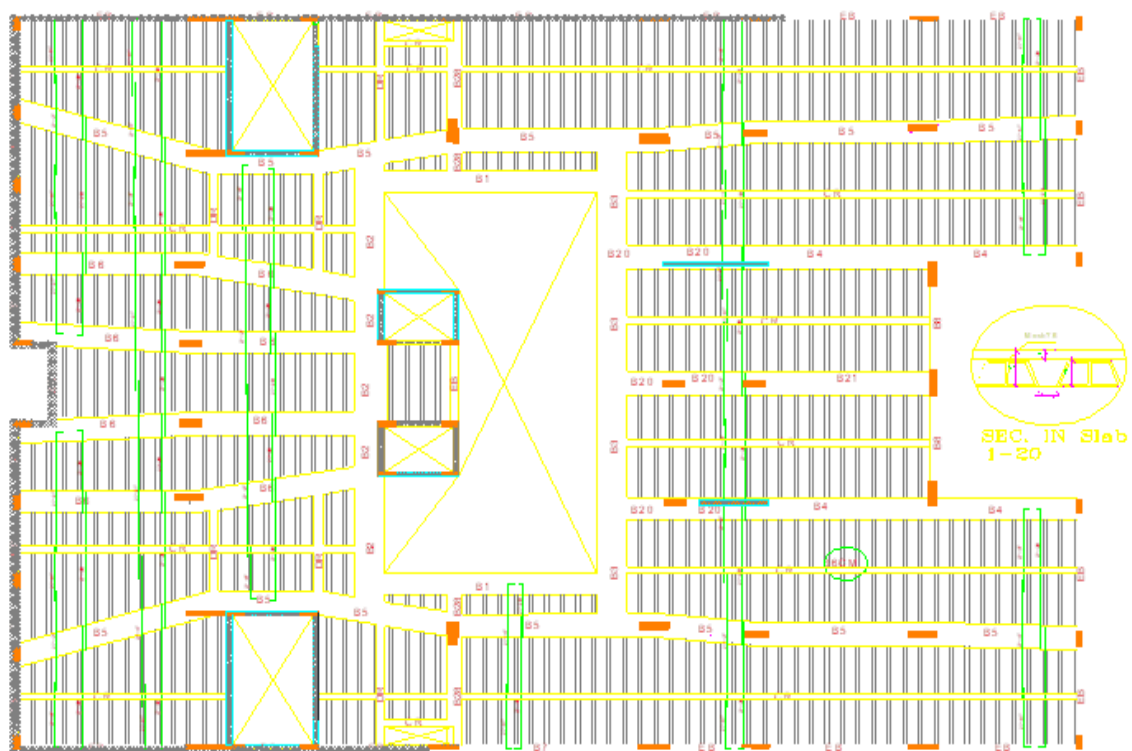
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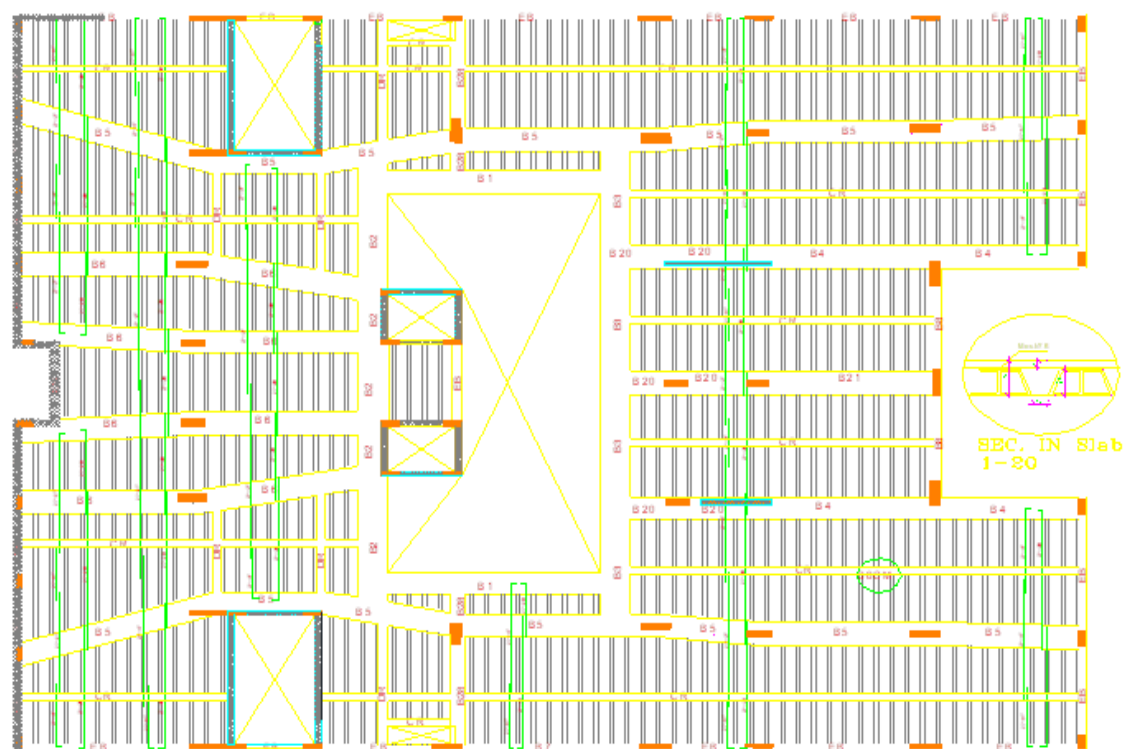




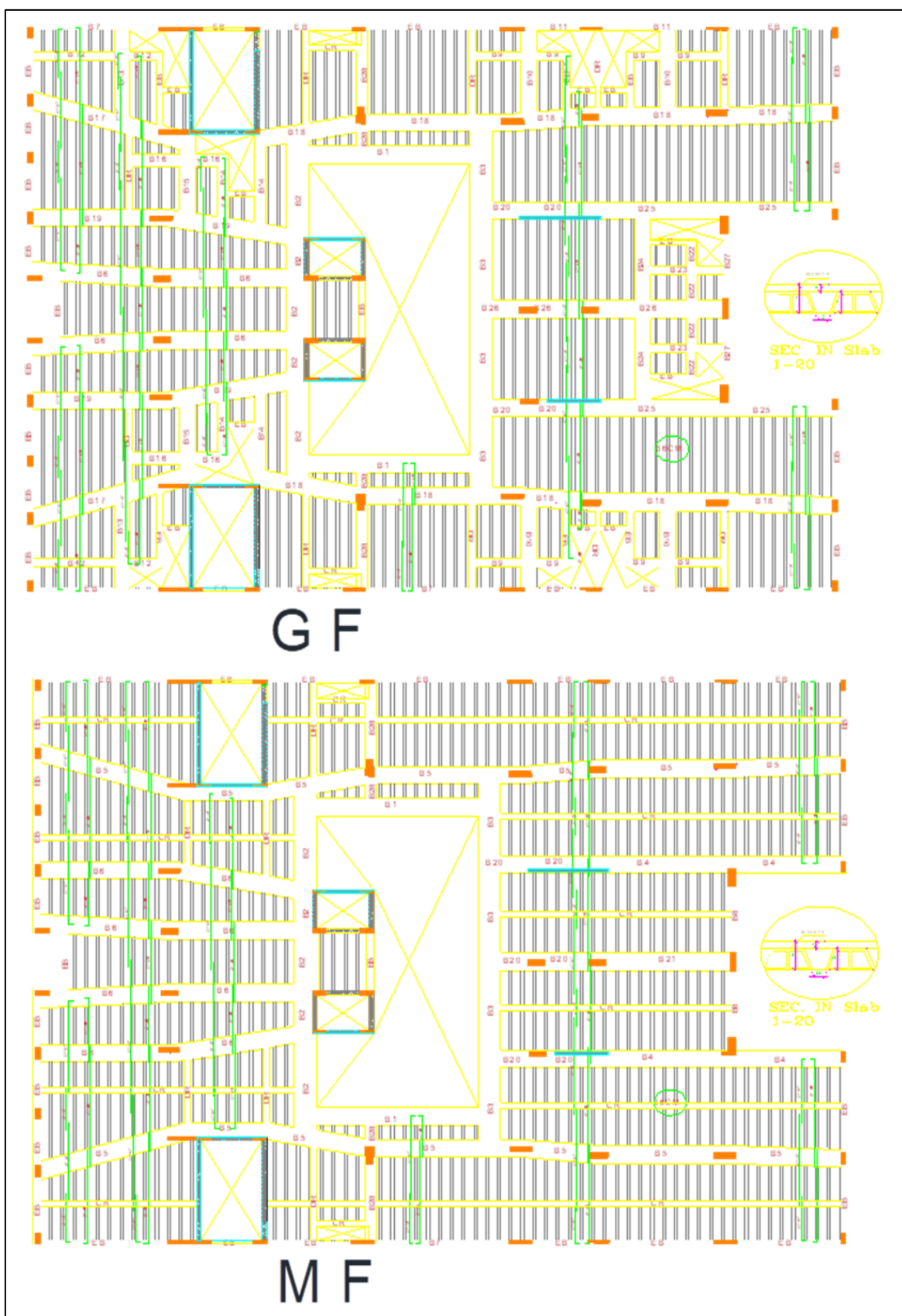


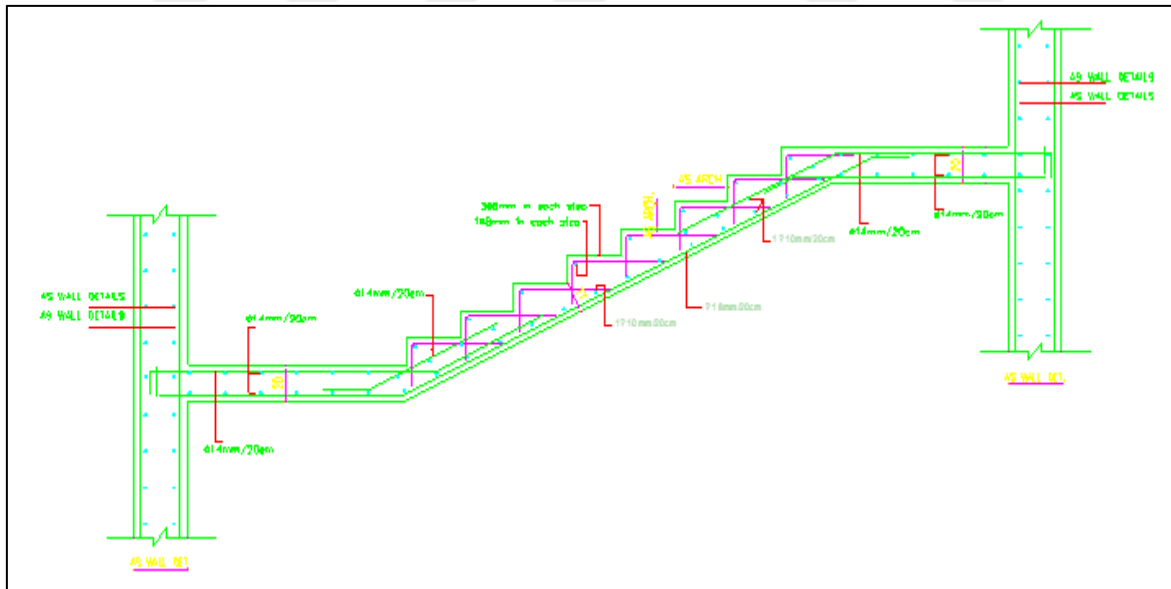


BF 2



BF 1





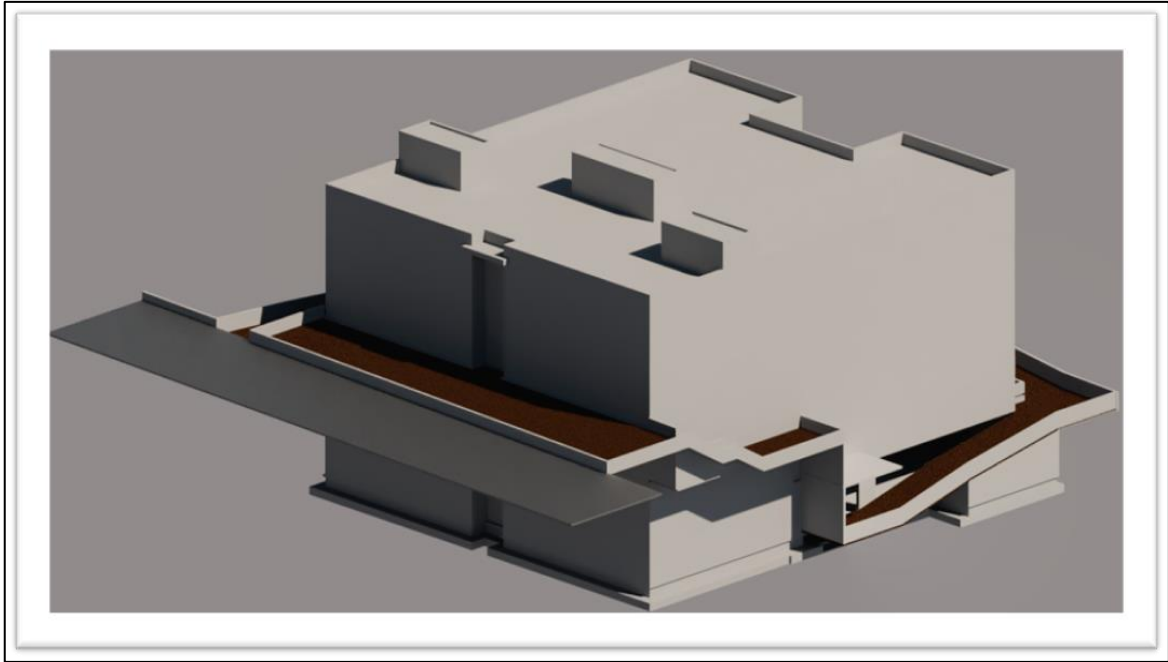


Figure B.1: A 3D Architecture of The Building Using The REVIT Software Modeling.

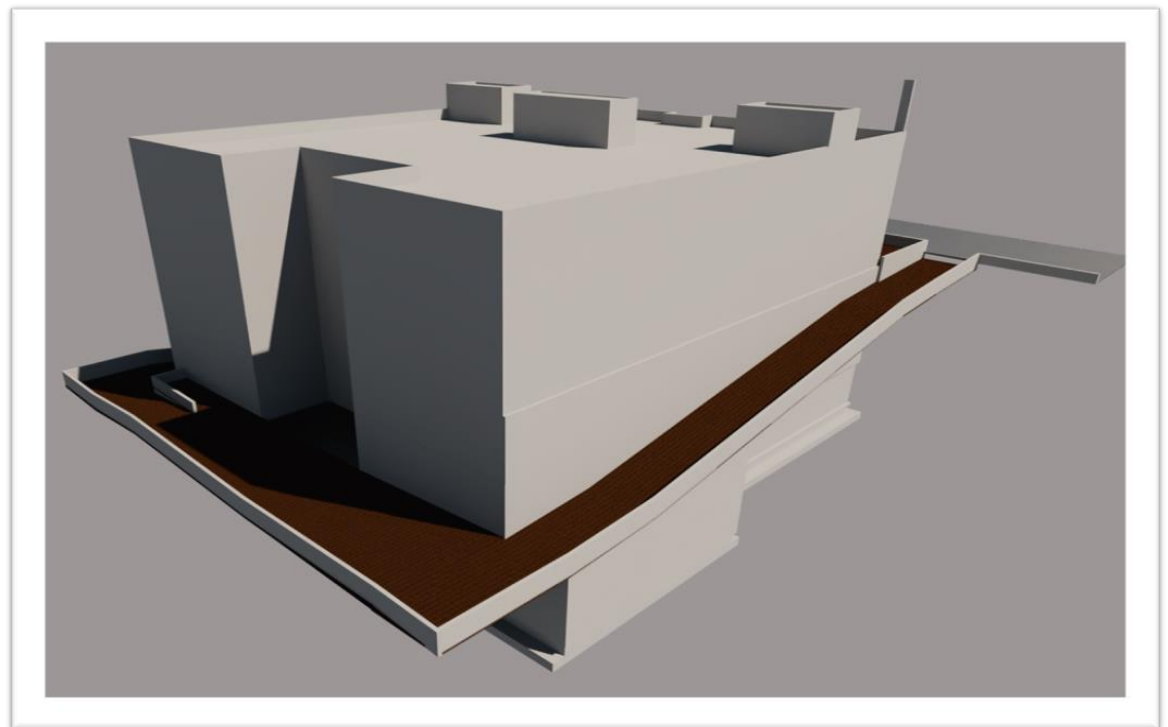


Figure B.2: A Second Overview of The Construction Project Analyzed Using The REVIT Software Tool.

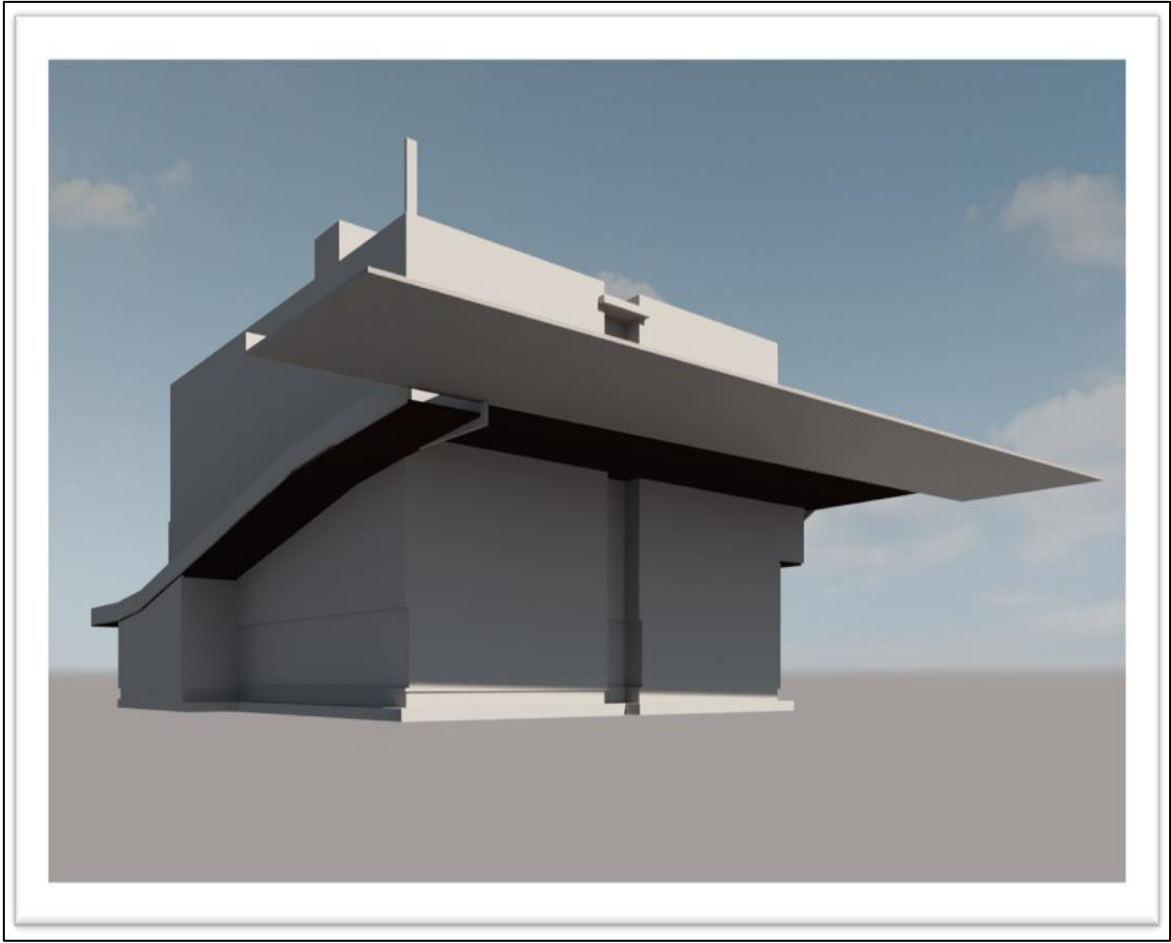


Figure B.3: A Third Overview of The Construction Project Analyzed Using The REVIT Software Tool.



Figure B.4: A Fourth Overview of The Construction Project Analyzed Using The REVIT Software Tool.



Figure B.5: A fifth overview of the construction project analyzed using the REVIT software tool.



Figure B.6: A Front 3D View of The Construction Project Analyzed Via The REVIT Software Tool.

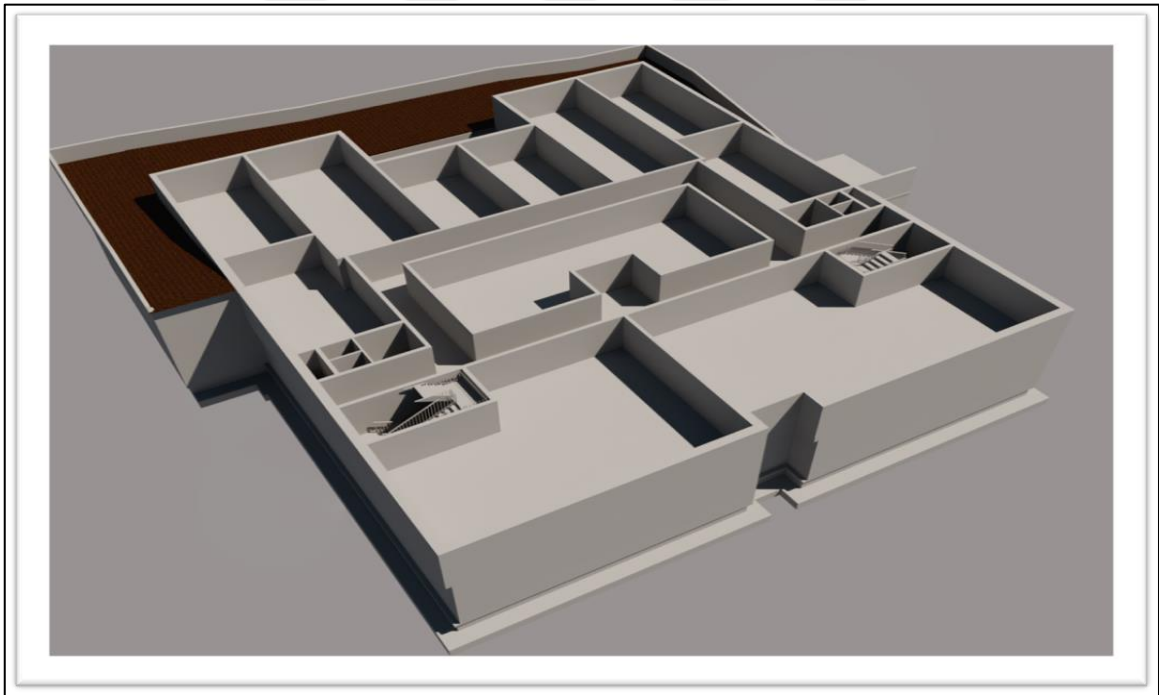


Figure B.7: A top 3D View of The Construction Project (For The Ground Floor) Analyzed Using The REVIT Software Tool.

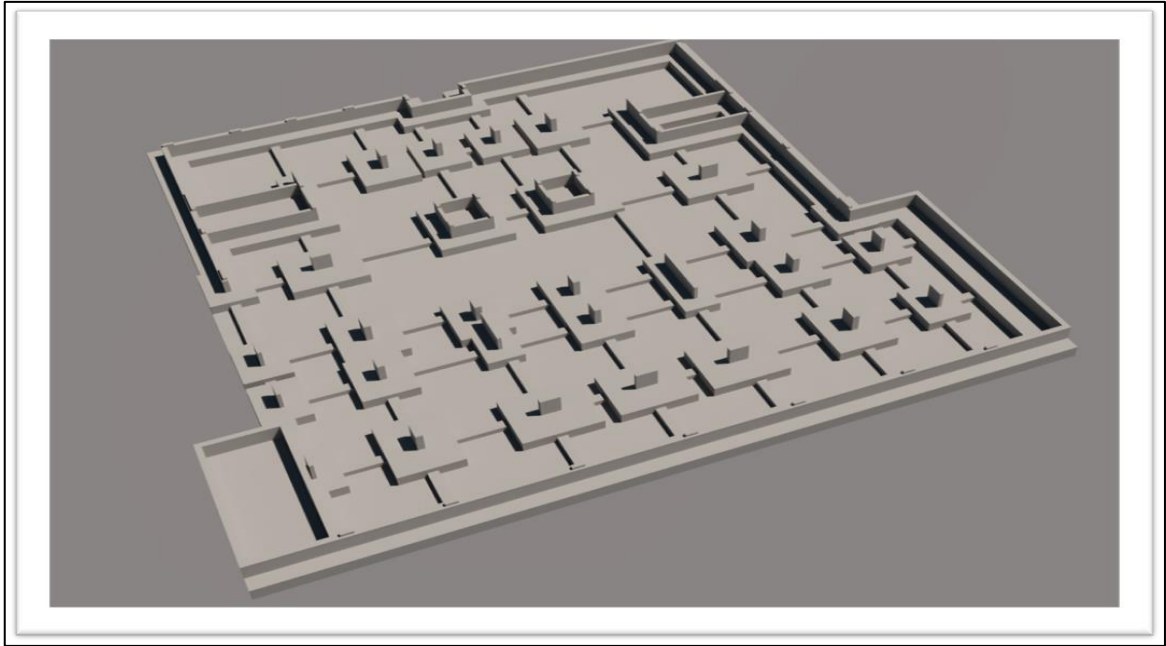


Figure B.8: A top 3D View of The Construction Project's Foundation Investigated Using The REVIT Software Tool.

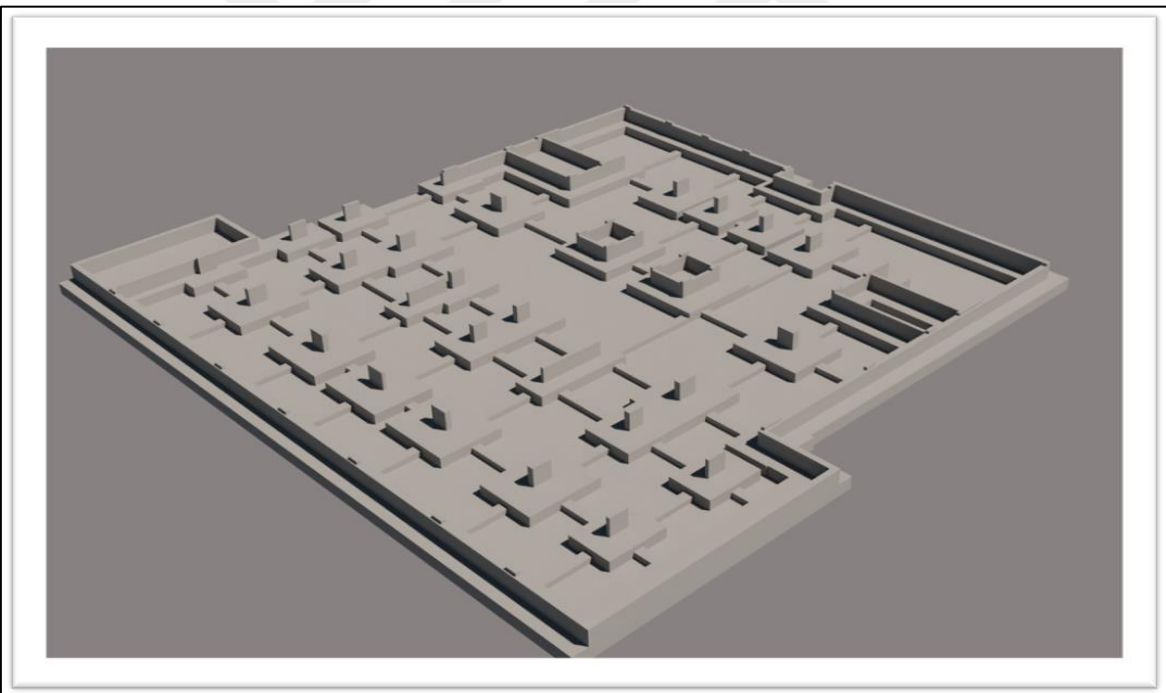


Figure B.9: A Second Top 3D View of The Construction Project's Foundation Investigated Using The REVIT Software Tool.

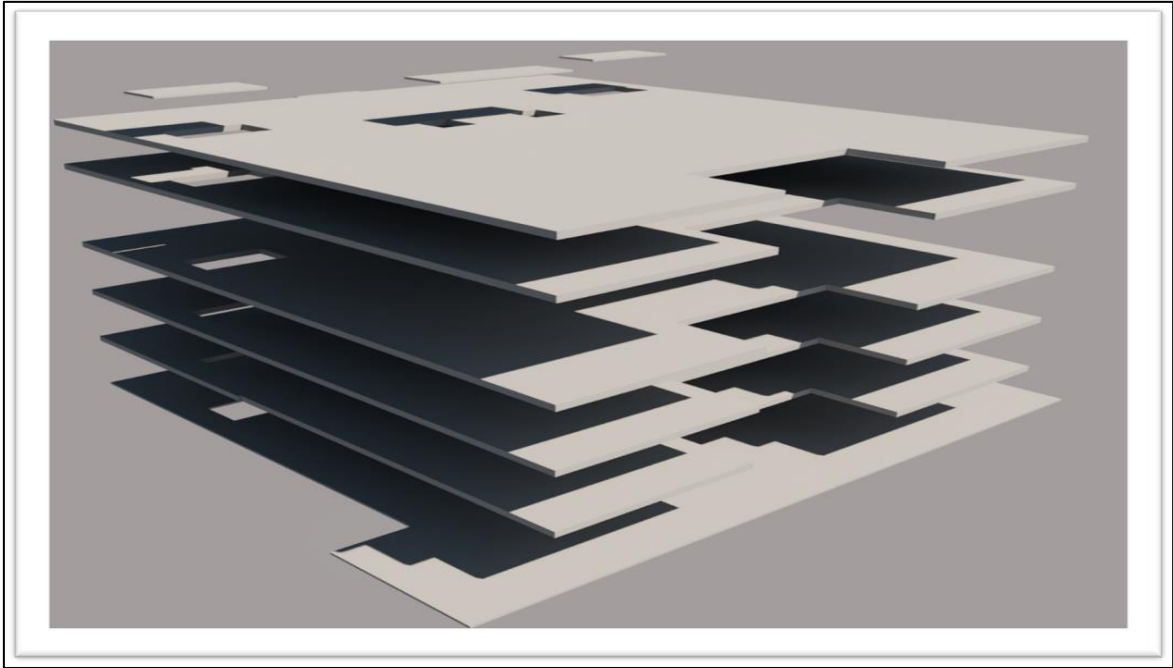


Figure B.10: 3D Configuration of The Slabs Examined Using The REVIT Software Tool.



Figure B.11: 3D Configuration of The Staircase Using The REVIT Software Tool.