

**A Web-Based Construction Project Management Platform for
FIDIC Construction Contracts: Enhancing Collaboration and
Reduce Claims through Digitalized Contractual Communication**



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Thesis Titled

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ABSTRACT

This research project aims at replacing traditional paper-based methods with a digital platform, also it aims to improve communication and collaboration among stakeholders, while also providing a centralized location for tracking project progress and timelines. We used FIDIC standard contracts 1987 and 1992 Red Book versions, PEC standard bidding documents, and contracts based on FIDIC conditions of contract for our comprehensive research work. We create an online platform that streamlines and automates contractual communication among stakeholders involved in a specific project. The platform will serve as a digital repository for all communication records, enabling stakeholders to access and communicate about subject matters efficiently and economically. This platform will provide a secure and reliable way to store and access records and documentation, reducing the risk of loss or damage to physical records. This can help ensure that records and documentation are available when needed, without the risk of delays or difficulties accessing the necessary information. When a claim arises, certain documents and a record of issuance, acceptance and submission are needed. From this platform, we shall have proper records with respect to proper dates of issuance, acceptance, and submission available on time. In this way, many claims and disputes are reduced compared to traditional paper-based work in which records are unavailable on time and sometimes we do not have any records, This platform solves the problem.

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LIST OF ABBREVIATIONS

| | |
|--------------|---|
| FIDIC | Fédération Internationale des Ingénieurs-Conseils |
| PEC | Pakistan Engineering Council |
| GCC | General Conditions of Contract |
| PCC | Particular Conditions of Contract |
| PC-1 | Project Concept-1 |
| JS | Java Script |
| SBDs | Standard Bidding Documents |
| JCT | Joint Contracts Tribunal |
| NEC | New Engineering Contract |
| AIA | American Institute of Architects |
| EJCDC | Engineers Joint Contract Documents Committee |
| GC21 | General Conditions of Contract for Construction |
| JBCC | Joint Building Contracts Committee |

1. Introduction

1.1 Background

The construction industry is one of the top contributing industries to the GDP growth of an economy. It has a very vital role in the development of a nation. An economy's productivity performance can only be as good as the performance of its constituent parts. The construction industry is a significant contributor to the economy in most countries (Wahab & Vogl, 2011).

The construction industry is a vital sector that contributes significantly to economic growth and development. It is a complex and dynamic industry that involves multiple stakeholders, such as clients, designers, contractors, subcontractors, suppliers, and regulatory bodies. (Zhang and Goh (2017))

The role of construction management is particularly important in large and complex construction projects, which involve multiple stakeholders and require careful coordination and management. Construction management helps to ensure that construction projects are completed efficiently and effectively, by coordinating the efforts of all stakeholders and managing resources, timelines, and budgets. (Iqbal et al. (2019))

Development of legally binding correspondence alludes to the trading of data, documents, and correspondence between stakeholders involved in a construction project, including the owner, contractor, designers, and subcontractors. Efficient contractual communication is crucial for a building project's success, as it facilitates collaboration, reduces the risk of disputes and conflicts, and guarantees that the project is finished on schedule, within the allotted budget, and to the necessary levels of quality.

The efficiency of contractual communication is critical for the success of construction projects (Niamir-Fuller et al. (2018)). The study found that effective communication between project stakeholders plays an important role in ensuring project success and that poor communication is a major cause of delays, cost overruns, and disputes in construction projects.

Stakeholders in construction projects are individuals or organizations who have an interest in the project and are affected by its outcome. These stakeholders include owners, contractors, designers, subcontractors, suppliers, regulators, and end-users.

Traditionally, communication in the construction industry in Pakistan has been done through paper-based documentation, phone calls, emails, and in-person meetings. This approach can be time-consuming and inefficient, especially when stakeholders are geographically dispersed.

Contracts, change orders, and other documents are often printed out and physically signed. This can lead to delays in communication and potential errors in documentation. In addition, tracking the progress of a project can be difficult due to the fragmented nature of communication.

In addition to the issues of delays and errors in traditional communication methods in the construction industry in Pakistan, there are other challenges as well. These include the lack of standardization in documentation and communication practices, as well as the potential for disputes and legal issues due to incomplete or unclear documentation.

Furthermore, there are issues of transparency and Accountability in Pakistan's construction sector, which can lead to corruption and other unethical practices. The lack of access to information and documentation can make it difficult to hold stakeholders accountable for their actions and watch out for the timely and cost-effective completion of projects.

The use of digital communication platforms in Pakistan's construction industry is still in its initial stages. As the construction industry in Pakistan continues to grow and become more complex, there is a growing need for digital communication platforms that can streamline communication and documentation.

Digital communication platforms have the potential to address many of these issues by providing a centralized location for all project-related communication and documentation. This can help to standardize documentation practices and make it easier to track the progress of a project. In addition, digital platforms can provide better transparency and accountability by allowing all stakeholders to access the same information and documentation.

A traditional paper-based contract management system can be a cumbersome and time-consuming process. In such systems, documents and communication records related to a project are often scattered across various locations and stakeholders, making it difficult to track the progress of the project or to maintain a centralized database. Moreover, this kind of system is prone to errors, delays, and miscommunications, which can result in costly mistakes.

To address these challenges, our research proposes the development of an online platform for efficient and secure contractual communication, collaboration, and documentation management. This platform will enable stakeholders to easily access and share project-related information, including communication records, budgets, timelines, and progress reports, in real time. The platform will be designed to ensure that all stakeholders have access to the same information, reducing the risk of miscommunications or errors due to incomplete or outdated information.

By moving from a traditional paper-based system to an online platform, our research aims to streamline the contract management process and increase project communication and collaboration efficiency and effectiveness. The benefits of such a system are numerous, including improved transparency, enhanced decision-making, and reduced costs associated with delays, errors, and inefficiencies. Overall, the researched proposed platform will enable stakeholders to better manage projects, ensuring that they are finished to everyone's delight, on schedule, and within budget.

1.2 Research Significance

The construction industry is one of the largest employment generating industries in the world. The construction, renovation, maintenance and demolition of buildings and civil engineering projects together accounted for over 273 million (part-time and full time) jobs worldwide in 2014,

constituting an estimated 8.6% of the total global employment (Infrastructure and Cities for Economic Development (ICED), 2018).

The construction industry, being the driving force behind the world's economy, still lacks technological advancements as compared to other industries. The construction industry has experienced a lack of efficiency improvement. It has only managed to reach half of the efficiency improvements compared to other industries in the last 50 years (Kraatz, Hampson, & Sanchez, 2014).

One of the major reasons for the construction industry lagging other industries in efficiency is lack of digitalization and automation. This lack of automation and digitization puts hindrances in the workflows of construction processes. The sub-optimal working process is caused by fundamental problems with time overruns, quality problems, conflicts between stakeholders and a low level of knowledge transfer between actors (Kraatz, Hampson, & Sanchez, 2014).

Pakistan is a developing country that is currently enjoying vigorous growth in construction activities. Today, construction is the second largest sector in Pakistan's economy after agriculture. 30-35% of employment is directly or indirectly affiliated with the construction sector. The construction sector in Pakistan has played an important role in providing jobs and facilitating the revival of the economy (Farooqui & Ahmed, 2008).

The online platform for construction communication record keeping will help to address the challenges related to timely access to records and documentation in Pakistan's construction industry. Currently, traditional paper-based recordkeeping can lead to delays and difficulties in accessing the necessary records and documentation, especially in cases where claims or disputes arise.

By providing a centralized location for all communication records related to a construction project, the platform will ensure that stakeholders can access the necessary records and documentation on time. The platform will enable stakeholders to locate relevant documents and correspondence quickly and easily, eliminating the need to search through stacks of paper records or wait for physical copies to be delivered.

Additionally, the platform will provide real-time updates on the progress, and timelines of the project, which can help stakeholders to see potential problems and fix them before they turn into significant concerns. This can lessen the possibility of delays and cost overruns leading to claims or disputes in the first place.

Furthermore, the platform will provide a secure and reliable way to store and access records and documentation, reducing the risk of loss or damage to physical records. This can help ensure that records and documentation are available when needed, without the risk of delays or difficulties accessing the necessary information.

Overall, the online platform for construction communication record keeping will provide a more efficient and effective way for stakeholders to manage and access records and documentation related to a construction project. This can help to prevent delays and disputes and ensure that stakeholders have access to the information they need to support their claims and make informed decisions.

1.2 Problem Statement:

Traditional paper-based contract management systems have been criticized for being inefficient, error-prone, and costly (Davies, 2019). The lack of a centralized platform for stakeholders to

communicate and track project progress, budgets, timelines, and all communication records in real-time is a significant challenge to effective contract management. Moreover, the risk of loss or damage to physical records can cause difficulties in accessing necessary information and can result in disputes and claims (Tarek et al., 2016). The reliance on paper-based work in the construction sector in Pakistan is the lack of a unified digital infrastructure. Currently, there is no standard or widely accepted digital platform or system that all parties involved in the building sector may utilize. This can lead to a fragmented approach where each stakeholder may use their own preferred method or system, which can make it difficult to integrate information and collaborate effectively. When a claim arises, certain documents and a record of issuance, acceptance and submission are needed. From this platform, we shall have proper records with respect to proper dates of issuance, acceptance, and submission available on time. In this way, many claims and disputes are reduced compared to traditional paper-based work in which records are unavailable on time and sometimes we do not have any record. The world is growing and moving towards digitalization and automation; it is a need of time to automate the process.

1.4 Research Objectives

The research aims at:

- Replace traditional paper-based work to a secure platform.
- Ease of contractual obligations understanding
- Enhance the efficiency and effectiveness of contract management.
- Improve communication and collaboration among stakeholders, while also providing a centralized location for tracking project progress and timelines.
- Providing a secure and reliable way to store and access records and documentation and reducing the risk of loss or damage to physical records.
- Lower the expenses incurred as a result of mistakes, inefficiencies, and delays, and make sure that projects are finished on schedule, within budget, and to the satisfaction of all stakeholders.
- Transparency and stakeholders accountable for their actions.

1.5 Summary

This research project aims to address the issues discussed above by replacing traditional paper-based methods with a digital platform. Developing an online platform that streamlines and automates contractual communication among stakeholders involved in the construction sector in Pakistan. The platform will provide a secure and reliable way to store and access records and documentation, reducing the risk of loss or damage to physical records. It enhances the efficiency and effectiveness of contract management in the construction sector in Pakistan, reducing costs associated with delays, errors, and inefficiencies, and ensuring that Projects are finished on schedule, under budget, and to each party's satisfaction.

2. Literature Review

2.1 Problems in the Construction Industry of Pakistan

The construction industry in Pakistan still relies on paper-based work. Firstly, many construction firms in Pakistan are small or medium-sized enterprises, which may not have the resources or capacity to invest in digital platforms or technologies. Implementing digital solutions may require significant investments in hardware, software, training, and infrastructure, which may be beyond the means of many small firms (Iftikhar et al., 2021).

Secondly, there is a lack of awareness and understanding among stakeholders about the benefits of digital platforms in the construction industry. Many stakeholders may perceive the use of paper-based records as a tried and tested method that is familiar and easy to use, while digital platforms may be seen as complex or difficult to implement (Shahzad et al., 2020).

Thirdly, the construction industry in Pakistan has a culture of face-to-face communication and personal relationships, which may not necessarily translate well to digital platforms. Building trust and rapport with stakeholders is important in the construction industry, and some stakeholders may feel that digital platforms can hinder interpersonal communication (Iftikhar et al., 2021).

Fourthly, there may be regulatory and legal barriers that prevent the widespread adoption of digital platforms in the construction industry in Pakistan. For example, there may be concerns about data privacy, security, and ownership, which can create legal and ethical challenges for the use of digital platforms (Shahzad et al., 2020).

Fifthly the reliance on paper-based work in the construction industry in Pakistan is the lack of a unified digital infrastructure. Currently, there is no standard or widely accepted digital platform or system that can be used by all stakeholders in the construction industry. This can lead to a fragmented approach where each stakeholder may use their own preferred method or system, which can make it difficult to integrate information and collaborate effectively (Iftikhar et al., 2021).

Moreover, there is a lack of incentives for stakeholders to adopt digital platforms. Many stakeholders may not see the immediate benefits of switching to digital platforms and may not be willing to invest the time and resources required to make the switch. This is particularly true for stakeholders who are focused on short-term gains and may not see the long-term benefits of digital platforms in terms of increased efficiency, productivity, and profitability (Shahzad et al., 2020).

Finally, there are also cultural factors that influence the adoption of digital platforms in the construction industry in Pakistan. For example, there may be a perception that the use of digital platforms is associated with westernization and may not be appropriate or acceptable in the Pakistani context. Additionally, there may be a lack of trust in digital platforms, particularly in terms of data privacy and security, which can make stakeholders hesitant to use these platforms (Iftikhar et al., 2021).

2.2 Industrial Opinion

From the feedback received from PMO NUST and contractors from construction industry of Pakistan, we deducted that the lack of awareness and implementation of technology is a major factor in the prioritization of traditional practices. The stakeholders in the industry seem to have little interest in achieving 100% transparency for their own side, and few want to be held

accountable for any mischiefs, flaws, or ignorance. As a result, manual and software-based work are still being carried out, and adopting a multi-tasking platform is considered unreliable due to the need for proper knowledge, literacy about the contracts, technical training, strict timelines, and transparency throughout the project.

Currently, the construction industry relies on software such as messaging, emails, small mobile applications, reminders, and phone calls. However, each project stakeholder has their own practices and sources to follow, and there is no unified technological infrastructure that all stakeholders can agree upon. This lack of agreement further hampers the adoption of new technologies.

Ultimately, the lack of transparency and willingness to adopt new technologies may compromise the profit margin as self-biased amounts may not be justified. In conclusion, the reasons behind the slow digital platforms being adopted by the construction sector in Pakistan are multifaceted and complex. Addressing these challenges will require a comprehensive approach that considers the unique cultural, social, economic, and regulatory factors that influence the construction industry in Pakistan.

2.3 Stakeholders Involved in the construction project

Contractor: "The party that undertakes the physical construction of a project in accordance with the contract documents and is responsible for delivering the project within the agreed time, cost and quality parameters." (Fewings, P. (2013). Construction Project Management: An Integrated Approach. London: Routledge, p. 70.)

Client: "The party that initiates a construction project and is responsible for ensuring that the project is completed successfully. The client may be an individual or an organization, such as a government agency or a private company. The client is responsible for defining the project requirements, selecting the contractor and engineer, and ensuring that the project is completed within the agreed-upon timeframe and budget." (Fewings, P. (2013). Construction Project Management: An Integrated Approach. London: Routledge, p. 70.)

The Engineer: "A professional who provides expert advice and assistance in a particular field or industry. In the construction industry, a consultant may provide specialized services such as project management, design review, cost estimating, or scheduling. Consultants are often engaged by the client to provide additional expertise or support to the project team." (American Society of Civil Engineers (ASCE). (2019). ASCE Construction Engineering Certificate Program: Construction Management Essentials. Reston, VA: ASCE, p. 15.)

2.4 GCC

Based upon analysis comprehensive of contracts, the General Conditions of Contracts we extracted are as follows:

| Sr. No | Clause No. | Clause Name |
|---------------|-------------------|---|
| 1 | 2.5 | Instructions in Writing |
| 2 | 2.3 | Engineer's Authority to Delegate |
| 3 | 10.1 | Performance Security |
| 4 | 10.2 | Period of Validity of Performance Security |
| 5 | 25.1 | Evidence and Terms of Insurance |
| 6 | 6.4 | Delay and Cost of Delay of Drawings |
| 7 | 6.5 | Failure by Contractor to Submit Drawings |
| 8 | 6.3 | Disruption of Progress |
| 9 | 7.1 | Supplementary Drawings and Instructions |
| 10 | 12.2 | Not Foreseeable Physical Obstructions or Condition |
| 11 | 14.1 | Programme to be Submitted |
| 12 | 14.2 | Revised Programme |
| 13 | 14.3 | Cash Flow Estimate to be submitted |
| 14 | 27.1 | Fossils |
| 15 | 30.3 | Transport of Materials or Plant |
| 16 | 31.3 | Opportunities for other Contractors |
| 17 | 31.2 | Facilities for other Contractors |
| 18 | 36.5 | Engineer's Determination where Tests not Provided for |
| 19 | 37.2 | Inspection and Testing |
| 20 | 37.3 | Dates for Inspection and Testing |
| 21 | 37.4 | Rejection |
| 22 | 37.5 | Independent Inspection |
| 23 | 38.1 | Examination of Work before Covering up |
| 24 | 38.2 | Uncovering and Making Openings |
| 25 | 39.2 | Default of Contractor in Compliance |
| 26 | 40.2 | Engineer's Determination following Suspension |
| 27 | 40.3 | Suspension lasting more than 84 days |
| 28 | 41.1 | Commencement of works |

| | | |
|----|------|--|
| 29 | 42.1 | Possession of Site and Access Thereto |
| 30 | 44.1 | Extension for Completion |
| 31 | 44.3 | Interim Determination of EOT |
| 32 | 46.1 | Rate of Progress |
| 33 | 48.1 | Taking Over Certificate |
| 34 | 52.1 | Valuation of Variations |
| 35 | 53.1 | Notice for Claim |
| 36 | 57.2 | Breakdown of Lumpsum items |
| 37 | 60.1 | Monthly Statement |
| 39 | 60.3 | Payment of Retention Money |
| 40 | 60.5 | Statement at Completion |
| 41 | 60.6 | Final Statement |
| 42 | 60.7 | Discharge |
| 43 | 60.8 | Final Payment Certificate |
| 44 | 60.1 | Time for Payment |
| 45 | 62.1 | Defect Liability Certificate |
| 46 | 63.1 | Default of Contractor |
| 47 | 67.1 | Engineer's Decision |
| 48 | 67.2 | Amicable Settlement |
| 49 | 69.1 | Default of Employer |
| 50 | 69.4 | Contractor's Entitlement to Suspend work |

Table 1

2.5 PCC and Special Provisions

Based upon analysis comprehensive of contracts, the Particular Conditions of Contracts and Special Provisions we extracted are as follows:

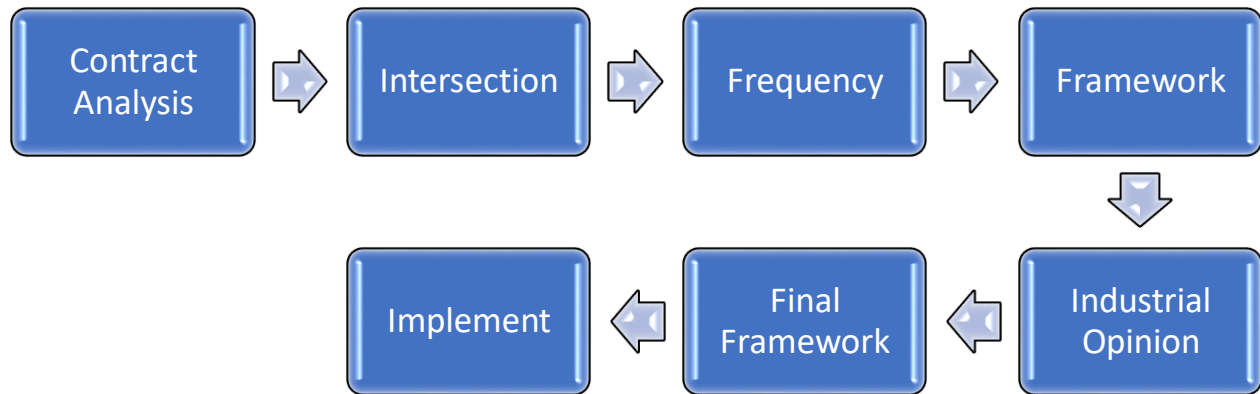
| Sr. No | Clause Name | Frequency | Communication between |
|---------------|------------------------------------|------------------|------------------------------|
| 1 | Replacement of Engineer | 20 | Employer and Contractor |
| 2 | As-Built Drawing | 22 | Contractor and Engineer |
| 3 | Shop Drawings | 30 | Contractor and Engineer |
| 4 | Performance Security | 36 | Contractor and Employer |
| 5 | Program to be submitted | 20 | Contractor and Engineer |
| 6 | Cash Flow Estimate to be submitted | 20 | Contractor and Engineer |
| 7 | Detailed Program | 20 | Contractor and Engineer |

| | | | |
|----|---|----|--|
| 8 | Monthly Progress Report | 20 | Contractor and Engineer |
| 9 | Daily or weekly Record of Work Progress and Photographs | 11 | Contractor and Engineer |
| 10 | Safety Precaution and Record of safety and health | 11 | Contractor and Engineer |
| 11 | Employment of Person in the service of others | 27 | Contractor and Engineer or Employer |
| 12 | Housing for labor | 27 | Contractor and Engineer(approval) and Employer |
| 13 | Reporting of Accidents | 18 | Contractor and Engineer |
| 14 | Termination of contract for Employer's Convenience | 29 | Contractor and Employer and Engineer (with a copy) |
| 15 | Commencement of work | 22 | Contractor and Engineer |
| 16 | Construction Drawings and Supplementary Drawings | 16 | Contractor and Engineer |
| 17 | Certification of Payment and Nominated subcontractor | 26 | Contractor and Engineer |
| 18 | Time for payment | 13 | Contractor and Employer and Engineer(copy) |
| 19 | Financial Assistance to Contractor | 15 | Contractor and Employer and Engineer |
| 20 | Notice to the contractor | 16 | Contractor and Employer and Engineer |
| 21 | Manufacturer's Recommendations | 16 | Contractor and Engineer |
| 22 | Inter disputes of Contractor and Sub-Contractors | 16 | Contractor with Engineer & Employer |
| 23 | Contractor's General Responsibilities | 25 | Contractor with Engineer & Employer |
| 24 | Revised Programme | 17 | Contractor with Engineer |
| 25 | Lighting Work at Night | 17 | Contractor with Engineer |
| 26 | Completion Inspection | 18 | Engineer & Contractor |

| | | | |
|----|---|----|---|
| 27 | Contractor's Representative | 29 | Contractor and Engineer |
| 28 | Conditions of Hire of Contractor's Equipment | 15 | Contractor and Engineer |
| 29 | Joint and Several Liability | 25 | Contractor and Employer |
| 30 | Custody and Supply of Drawings and Documents | 17 | Contractor, engineer, and employer |
| 31 | Notice to be given before work is covered up | 18 | Contractor and Engineer |
| 32 | Extension of time | 37 | Superintending Engineer, Chief Engineer, and Contractor |
| 33 | Action and compensation payable in case of bad work | 17 | Contractor and Engineer |
| 34 | Land acquisition and cost | 28 | Contractor, engineer, and employer |
| 35 | Attendances of Meetings | 39 | Contractor, engineer, or employer |
| 36 | Supply of Bitumen and Cement, etc. | 15 | Contractor, engineer, or employer |
| 37 | Borrow Areas | 14 | Contractor and engineer |
| 38 | Final Hand Over | 29 | Contractor and Employer |
| 39 | Making Good Damage to Service, Earthwork, etc. | 27 | Contractor and Employer |
| 40 | Returns of Plant, Materials, etc. | 15 | Contractor and Employer and Engineer |
| 41 | Record of Measurements | 18 | Contractor and Engineer |
| 42 | Fixed Withholding Tax | 15 | Contractor and Employer and Engineer(copy) |
| 43 | Termination of Contract for Failure to Become Effective | 18 | Contractor and Employer and Engineer |
| 44 | Insurance to be taken out by the Consultants | 16 | Contractor and Engineer |
| 45 | Professional Liability | 16 | Contractor and Employer and Engineer |

Table 2

3. Methodology



3.1 Contract Analysis

- Contract analysis involves thorough, and comprehensive analysis of standards and contracts used by construction companies in the field. Standard Contracts are FIDIC Red Book 1987, and 1992 version and the PEC Standard Construction Bidding Document
- We first extracted those GCC clauses from FIDIC Red Book 1987, and 1992 version and the PEC Standard Construction Bidding Document on which contractual communication happens between stakeholders.
- We then take about **one hundred** contraction contract bidding documents including RFPs and PC-1 and extracted those clauses in their PCC and Special Specification on which contractual communication takes place and noted what is different from PCC to PCC of documents and also marked the frequency of common clauses.

3.1.1 FIDIC

FIDIC (Fédération Internationale des Ingénieurs-Conseils) is an international organization that develops and promotes the use of standard contracts for the construction industry. FIDIC contracts are recognized worldwide as a standard for construction contracts and are commonly used in international construction projects.

FIDIC Construction Contract versions, along with their year of publication:

FIDIC Red Book - Conditions of Contract for Construction (1987, 1992, 2017)

FIDIC Yellow Book - Conditions of Contract for Plant and Design-Build (1987, 1999, 2017)

FIDIC Silver Book - Conditions of Contract for EPC/Turnkey Projects (1999, 2017)

FIDIC Green Book - Short Form of Contract (1999)

FIDIC Gold Book - Design, Build and Operate Projects (2008)

FIDIC Blue Book - Second Edition - Conditions of Contract for Dredging and Reclamation Works (2016)

The FIDIC Red Book 1987 is a standard form of contract that is designed for use on engineering and construction projects where the contractor carries out the design and construction of the works. The 1992 version is similar to the 1987 version, but with some significant changes, including the introduction of the Engineer as an independent third party to administer the contract. The 2017 version includes further revisions and updates to the contract, including changes to the dispute resolution process.

One of the main advantages of FIDIC contracts is their international recognition and widespread use. Because FIDIC contracts are recognized worldwide as a standard for construction contracts, they can help to promote consistency and clarity in contractual relationships between project stakeholders, including contractors, employers, and engineers.

FIDIC contracts also provide a framework for risk allocation and management, which can help to minimize disputes and ensure that projects are completed within budget and on time. For example, FIDIC contracts include provisions for addressing changes in scope, variations, and delays, as well as dispute resolution mechanisms such as mediation and arbitration.

Another advantage of FIDIC contracts is their flexibility. Although FIDIC contracts provide a standard framework, they can be customized to fit the specific needs of a project or region. This flexibility can help to ensure that contracts are tailored to the unique characteristics and challenges of each project, while still providing a common language and framework for project management and communication.

3.1.2 PC-1

In relation to Pakistan's construction initiatives, PC-1 stands for "Project Concept-1". It is a document that outlines the concept, scope, objectives, and estimated costs of a proposed project.

The PC-1 document is typically prepared by the project proponent or the sponsoring agency and is used as a basis for seeking approvals and funding from relevant authorities. It includes detailed information about the project, such as its location, design, expected outcomes, timelines, and budget.

The PC-1 document is effective in the planning and approval process for construction projects in Pakistan. It helps to ensure that projects are well-defined, feasible, and aligned with national development priorities. It also helps to provide transparency and accountability in the allocation of public funds for development projects.

The PC-1 document serves as a key planning and decision-making tool for construction projects in Pakistan and is an important step in the development of any new infrastructure or development initiative.

3.1.3 GCC and PCC

GCC stands for General Conditions of Contract, while PCC stands for Provincial Conditions of Contract. Both of these documents are used in construction contracts. The use of GCC and PCC in construction contracts is significant because they provide a standardized framework for the nature of the legal contract between the parties to a building project. This can help to ensure consistency and fairness in contracts, reduce the risk of disputes and claims arising from contract issues, and streamline the contracting process. Additionally, the use of standardized contracts can help to increase transparency and accountability in the procurement process, which can help to prevent corruption and promote good governance.

3.1.4 Special Provisions

Special specifications are additional or supplementary requirements that are unique to a specific project and are not covered by the standard specifications of the contract. They may include specific materials, design details, or construction methods that are required to fulfill the project requirements.

Special specifications are typically developed by the owner or client of the project and are included in the contract documents. They may be developed in collaboration with the contractor or design team or may be developed independently.

Special specifications are important in construction contracts as they help to ensure that the project meets the unique needs and requirements of the client. They also help to provide clarity and guidance for the contractor, design team, and other stakeholders involved in the project.

3.1.5 PEC Standard Bidding Document

PEC Standard Bidding Documents have been developed by the Pakistan Engineering Council in consultation with various stakeholders including the government, industry professionals, and construction associations. These documents are updated to ensure that they are consistent with international best practices and the evolving legal and regulatory framework in Pakistan.

The SBDs include several standardized forms, including prequalification documents, instructions to bidders, bid forms, and contract agreements. These documents help to ensure that all bidders are evaluated against a consistent set of criteria and that all bids are evaluated based on the same parameters. This can help to promote fairness and transparency in the procurement process and minimize the risk of legal disputes.

PEC Standard Bidding Documents also include guidance notes that provide instructions to procurement professionals on how to use the documents and conduct a fair and efficient

procurement process. These guidance notes cover various aspects of the procurement process, including pre-qualification of bidders, evaluation of bids, and selection of the successful bidder.

In addition to promoting transparency, fairness, and efficiency, the use of PEC Standard Bidding Documents can also help to reduce procurement costs and increase competition. By using standardized templates, clients can save time and resources in preparing bidding documents, while also ensuring that the documents are consistent and clear. This can help to attract a larger pool of qualified bidders, which can help to increase competition and drive down prices.

GCC and PCC are widely used in construction contracts around the world, including in Pakistan. In Pakistan, the government has developed standard bidding documents (SBDs) that include GCC and PCC clauses for use in public sector construction projects.

The Pakistan Engineering Council (PEC) is responsible for developing and implementing the SBDs. The GCC clauses in the PEC SBD-W include standard provisions for contract termination, variation, extension of time, and payment, among other things. The PCC clauses, on the other hand, are project-specific and include details such as the scope of work, schedule, and pricing.

The use of GCC and PCC in construction contracts is especially important in Pakistan, where the construction industry has been prone to disputes and legal challenges in the past. By using standardized documents like GCC and PCC, construction companies and government agencies can help to minimize the risk of disputes and ensure that contracts are executed in a transparent and efficient manner.

3.2 Intersection:

As part of our analysis of contracts and relevant documents, we carefully noted the common points and clauses that were present across our selected documents. We refer to this overlap as the "intersection" of these documents. By analyzing these commonalities, we were able to gain a deeper understanding of common points and clauses that are presently common in contracts, and how they intersect with each other.

3.3 Frequency

During our analysis of contracts and relevant documents, we carefully noted the frequency of occurrence of common points and clauses. This enabled us to gain a deeper understanding of prevailing industry standards and best practices. By leveraging this information, we were able to ensure that contracts used in specific projects align with established industry norms, thereby promoting greater consistency and coherence across our work.

3.4 Initial Framework

A brief conceptual network diagram we made containing all contractual communication points from start to finish of a project based on our initial analysis of contracts and documents.

3.5 Industrial Opinion

Obtaining input from industrial experts who have hands-on experience in the field is crucial for validating and refining our analysis work. To this end, we have engaged with multiple construction consultancies and contractor firms to solicit feedback and opinions on our findings, in order to identify any errors or discrepancies and improve the quality of our work. We have carefully recorded and incorporated their feedback into our analysis, ensuring that our work is informed by the latest industry insights and knowledge.

3.6 Final Framework

Based on lot of contracts and industrial opinion we developed our final framework in the form of flow chart which are as follows:



Figure 1

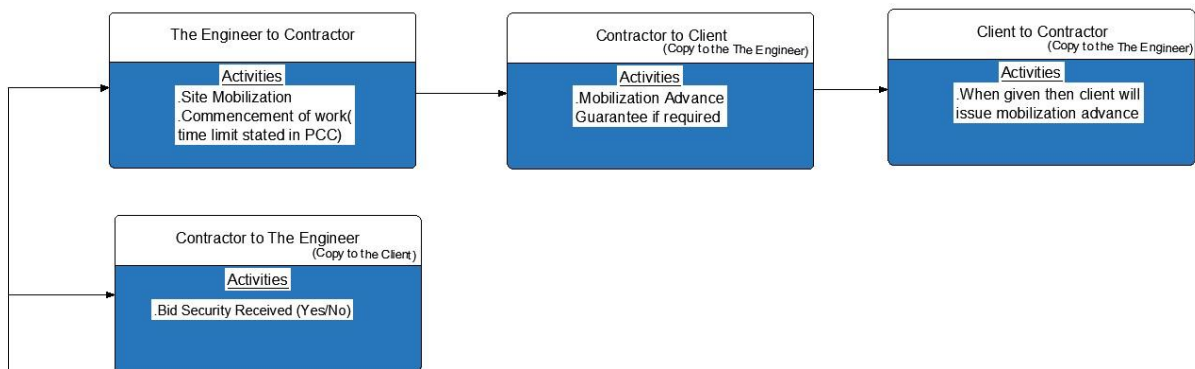
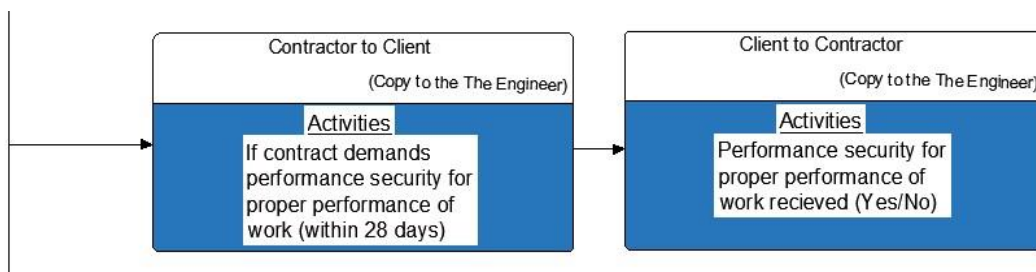


Figure 2



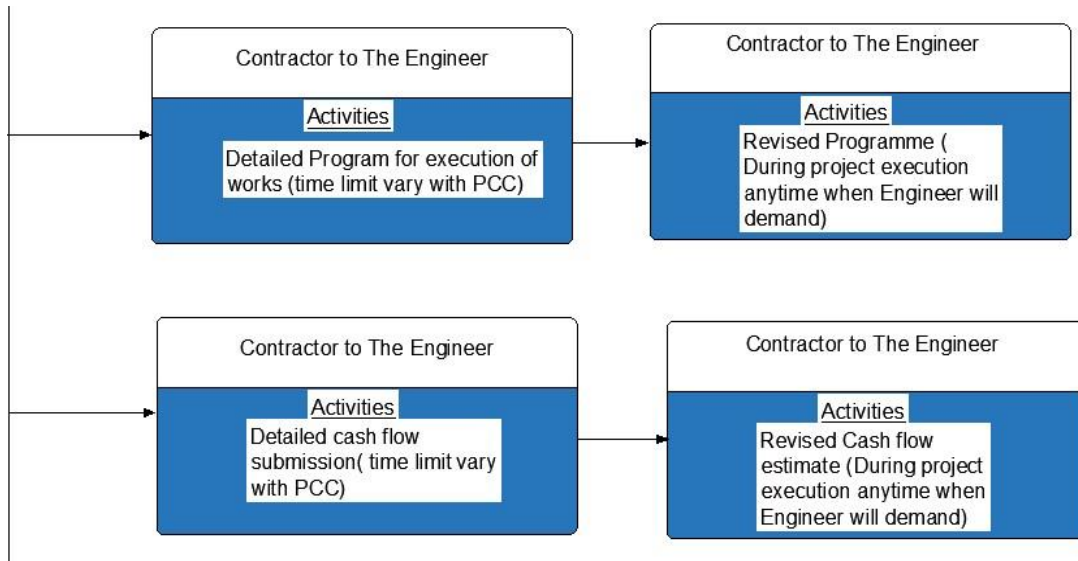


Figure 3

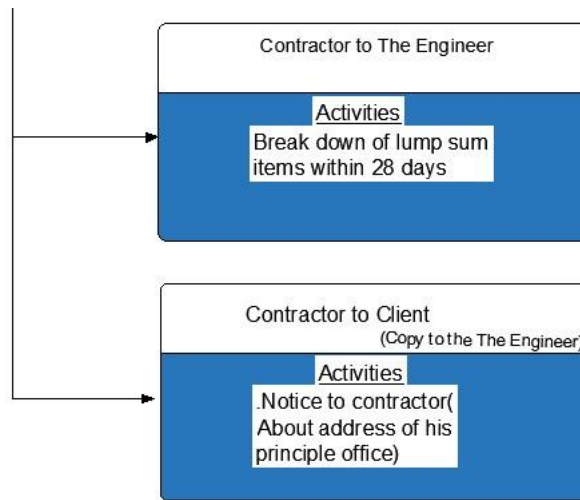


Figure 4

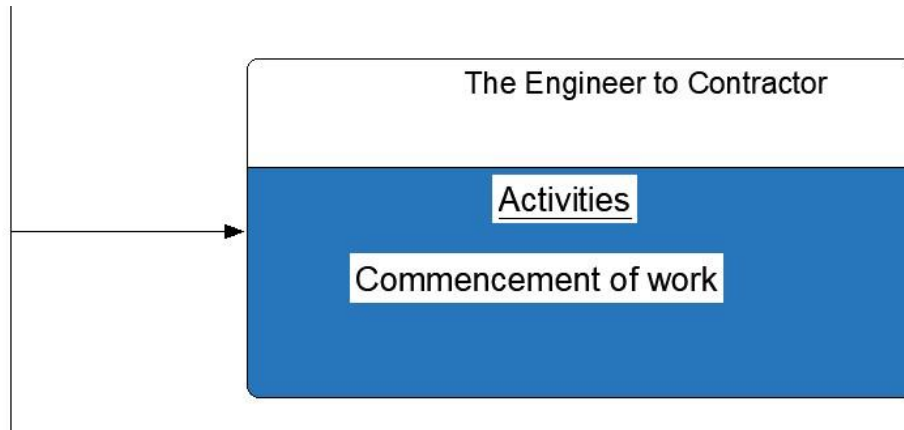


Figure 5

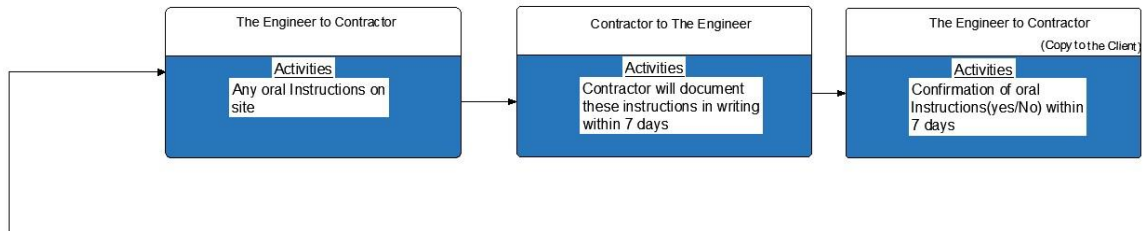


Figure 6

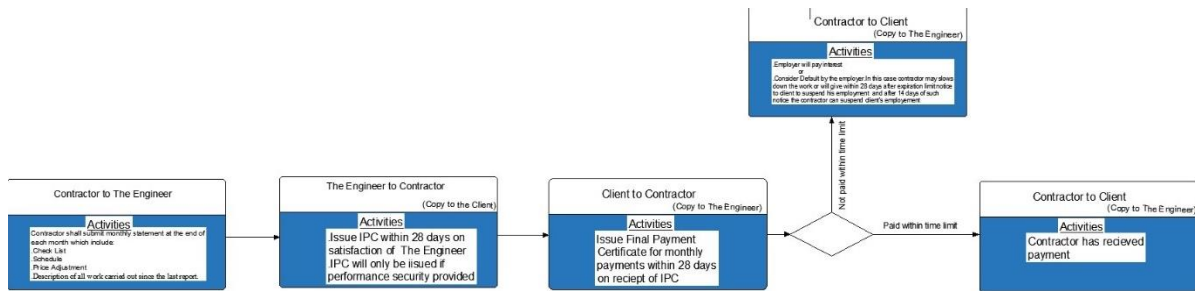


Figure 7

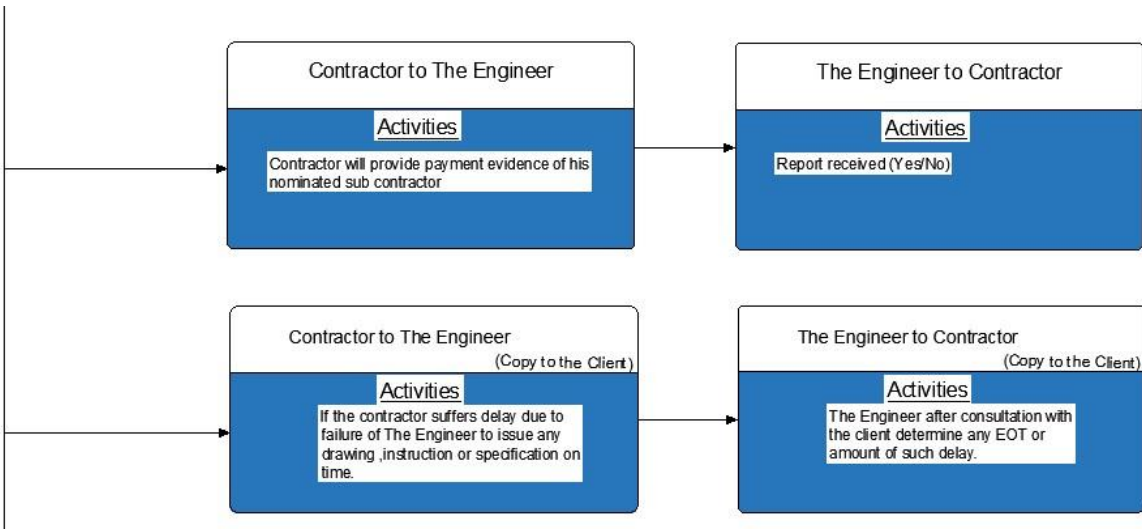


Figure 8

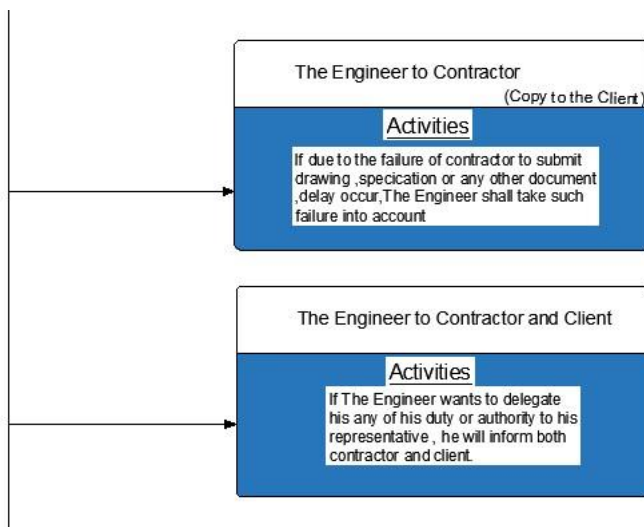


Figure 9

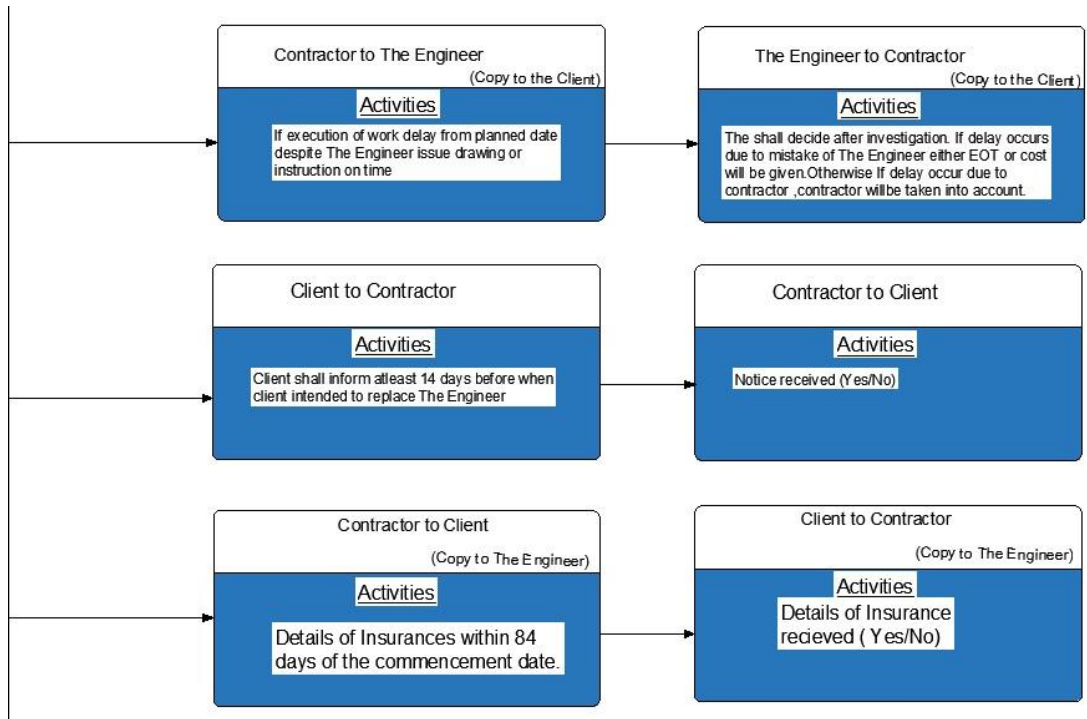


Figure 10

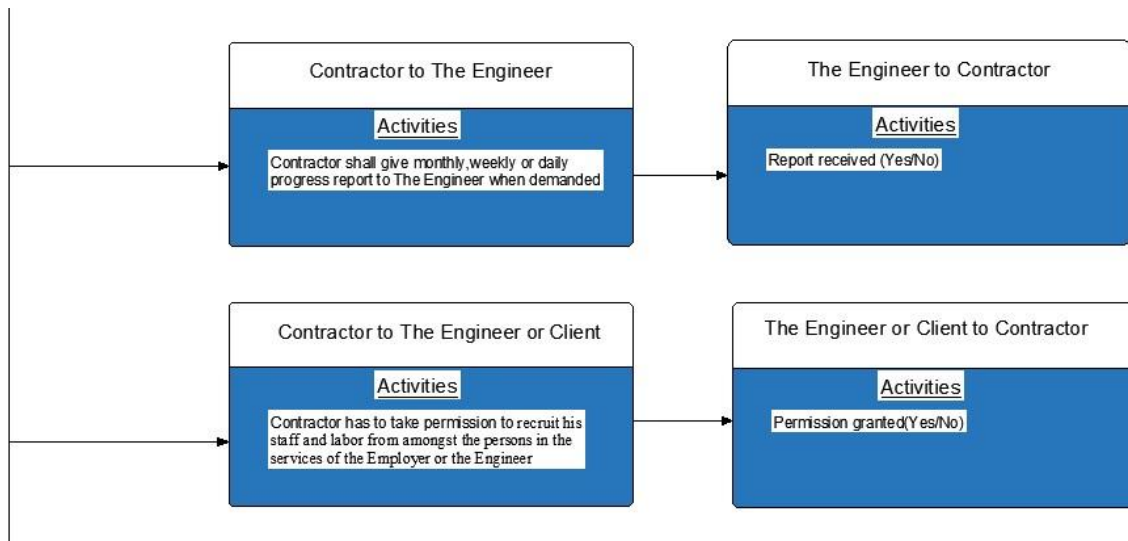


Figure 11

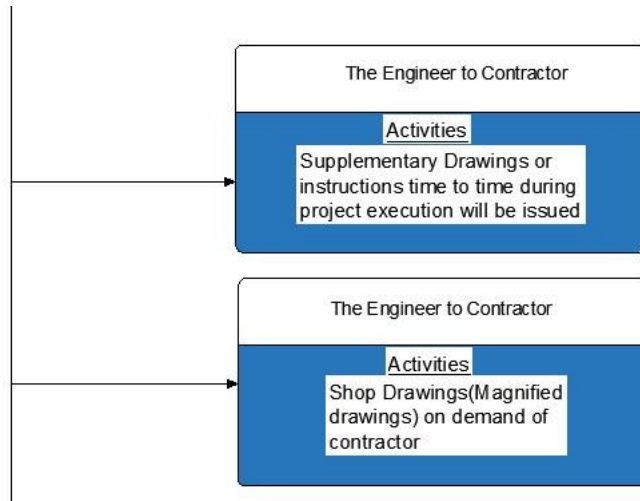


Figure 12

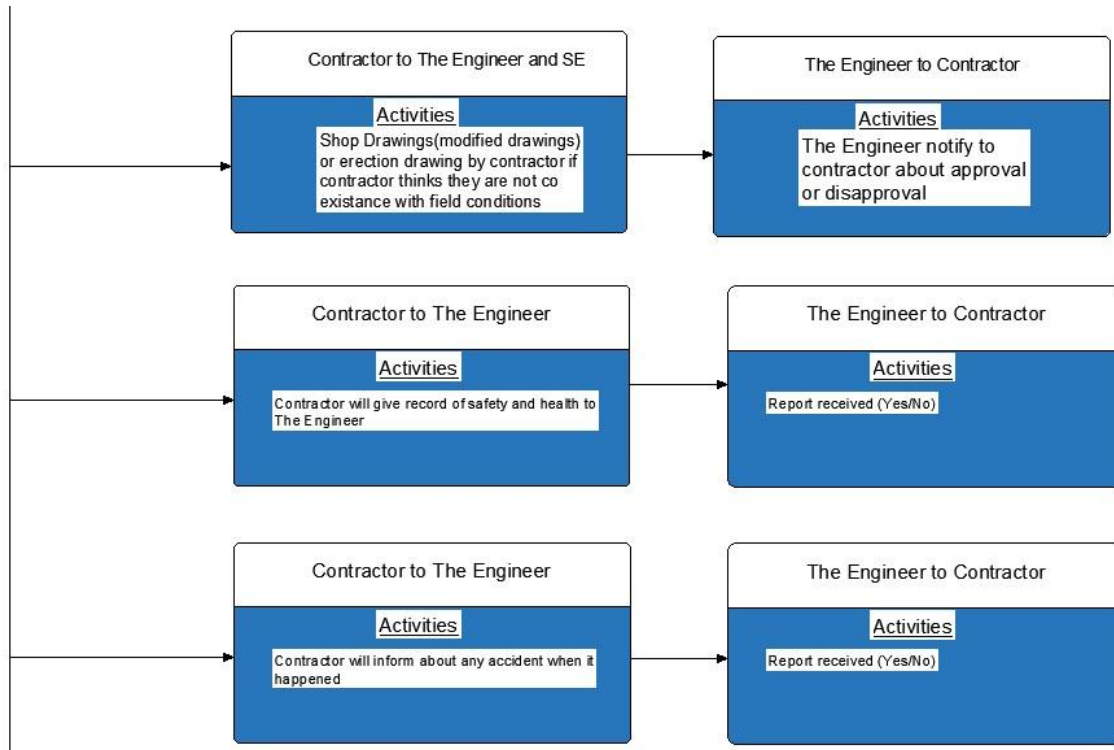


Figure 13

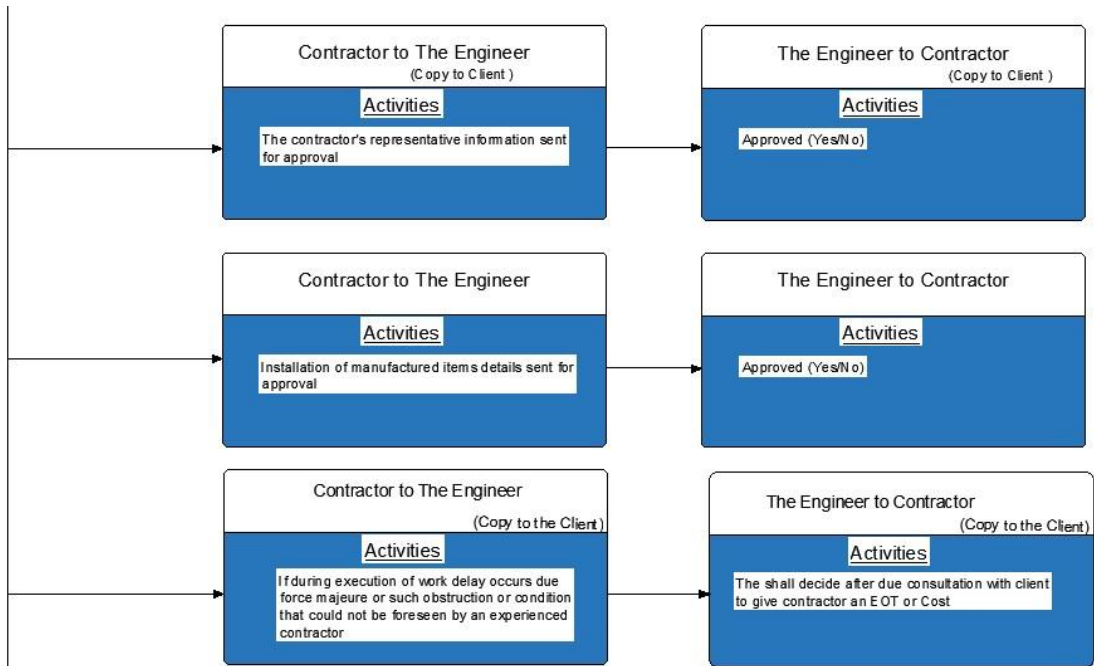


Figure 14

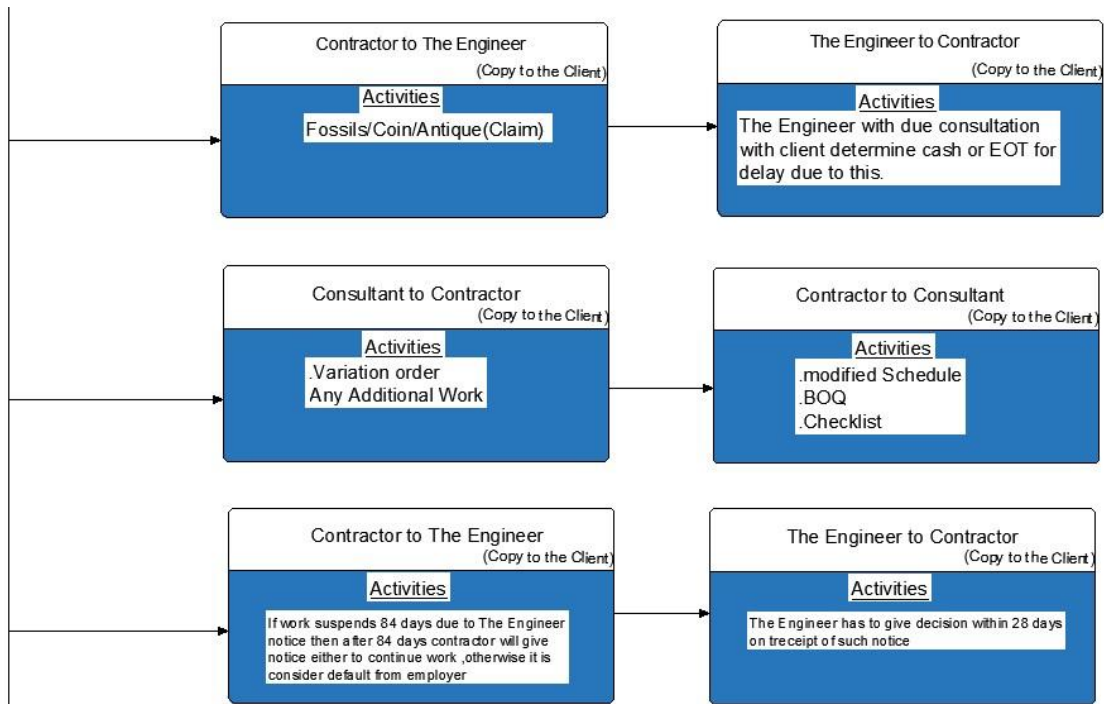


Figure 15

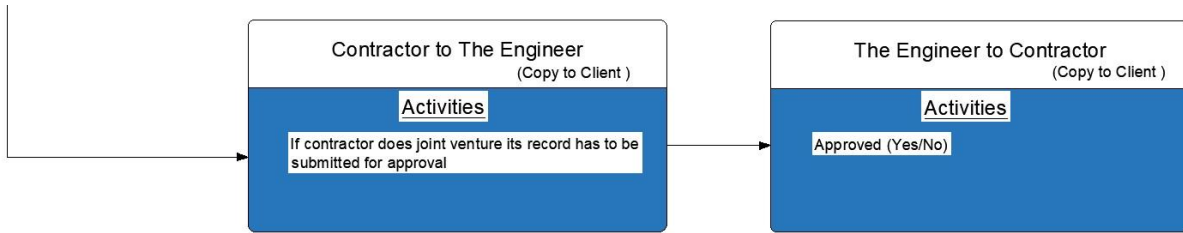


Figure 16

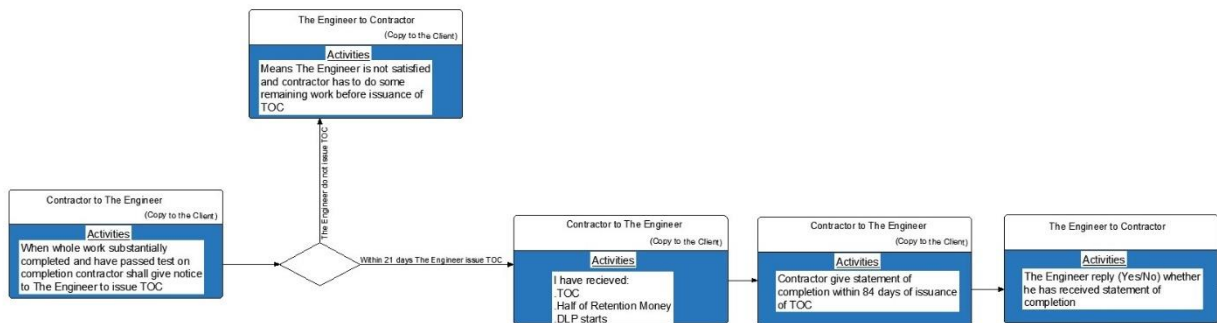


Figure 17

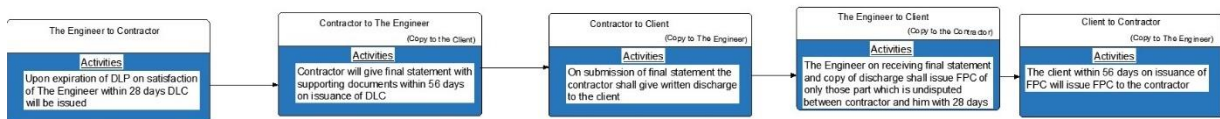


Figure 18

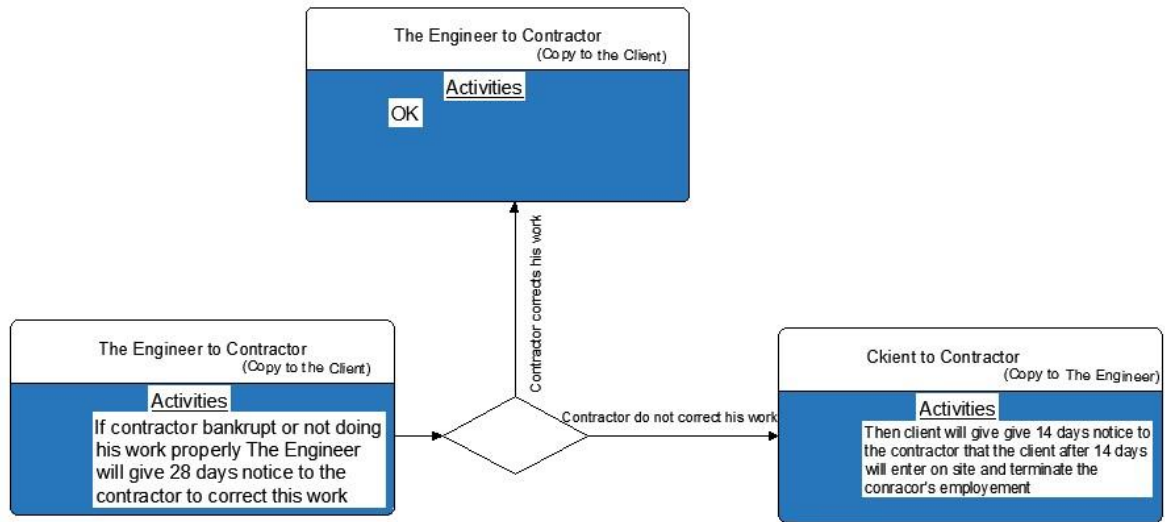


Figure 19

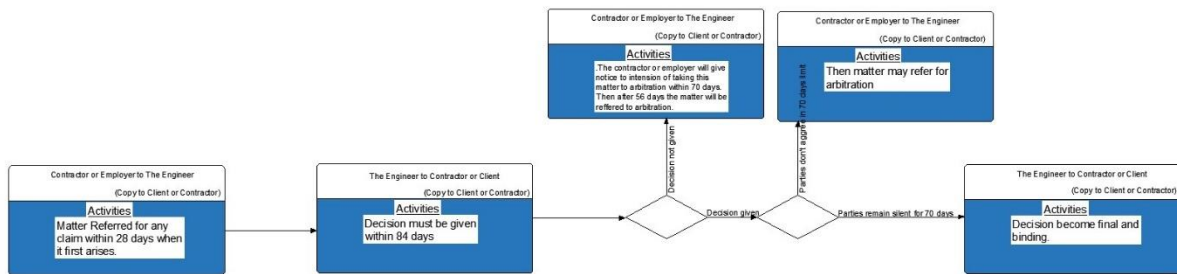


Figure 20

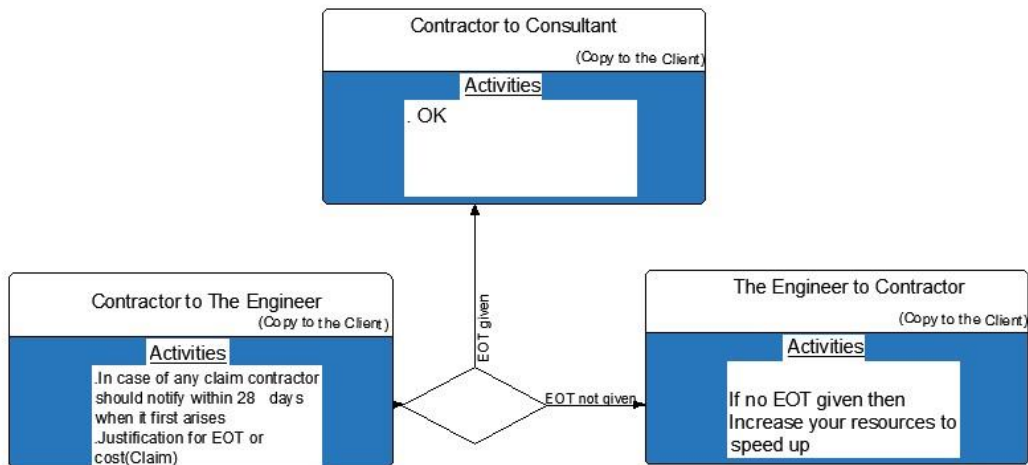


Figure 21

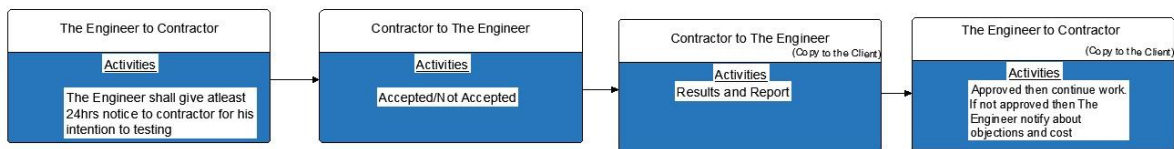


Figure 22

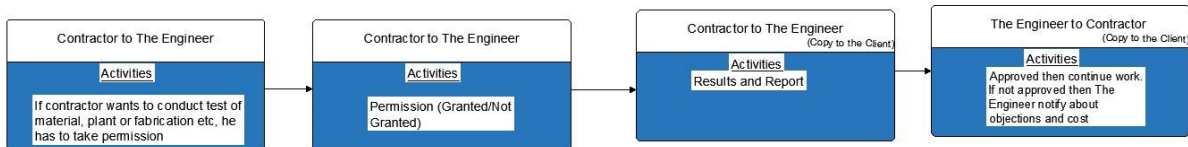


Figure 23

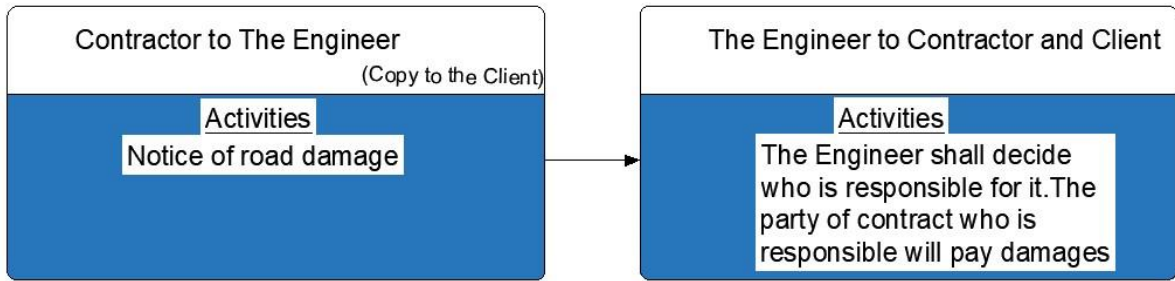


Figure 24

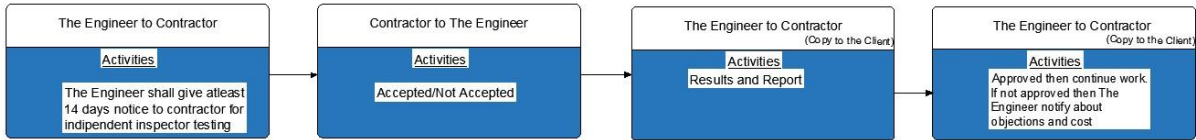


Figure 25

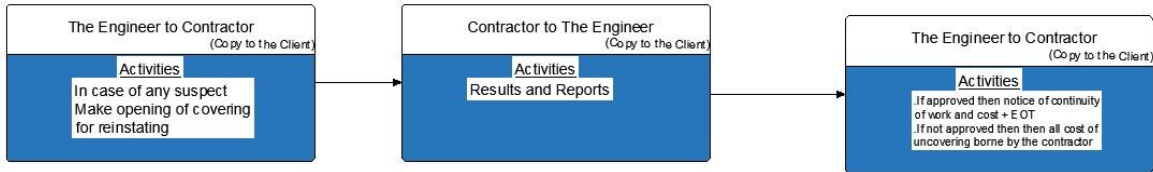


Figure 26

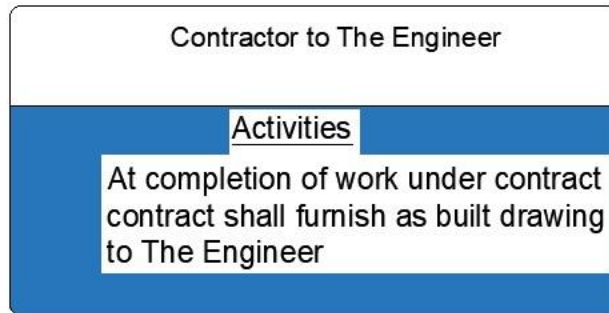


Figure 27

4. Results and Discussion

4.1 Implementation of the tool

We used Java Script for our web design.

4.1.1 Java Script

JavaScript is a programming language that is widely used for web development. It is primarily used for adding interactivity and dynamic behavior to websites. Some key aspects of JavaScript for web designing we used are as follow:

DOM manipulation: JavaScript allows web designers to manipulate the Document Object Model (DOM) of a web page. This means that you can use JavaScript to add, remove, or modify HTML elements, as well as change their properties and styles.

Event handling: JavaScript enables web designers to add event listeners to HTML elements. This means that you can use JavaScript to detect when a user clicks a button, hovers over an image, or scrolls down a page. You can then use this information to trigger actions or animations on the page.

AJAX: JavaScript also enables web designers to create asynchronous web applications using AJAX (Asynchronous JavaScript and XML). AJAX allows web pages to update content without refreshing the entire page, which can improve the user experience and make websites feel more responsive.

4.1.2 Libraries we Used

4.1.2.1 SERVER LIBs:

These are server-side libraries (or modules) for Node. We used to develop web applications.

```
"aws-sdk": "^2.1353.0",
```

```
"bcryptjs": "^2.4.3",  
"express": "^4.18.2",  
"nodemailer": "^6.9.1",  
"socket.io": "^4.6.1",
```

aws-sdk: This is the official JavaScript SDK for Amazon Web Services (AWS). It provides APIs for interacting with various AWS services, such as Amazon S3 (storage), Amazon EC2 (compute), and Amazon RDS (database).

bcryptjs: This is a JavaScript implementation of the bcrypt password hashing algorithm. It is commonly used to securely store passwords in a database by hashing them before storing them.

express: This is a popular Node.js web framework that simplifies the process of creating web applications. It provides features such as routing, middleware, and templating.

nodemailer: This is a module that provides an easy way to send email from Node.js applications. It supports various email protocols, such as SMTP, IMAP, and POP3.

socket.io: This is a real-time communication library that enables bidirectional communication between clients (such as web browsers) and a server. It is commonly used to create chat applications, online games, and other real-time applications.

Overall, these libraries help us to create robust, secure, and scalable server-side applications using Node.js.

4.1.2.2 FrontEnd LIBs :

These are Front-end libraries we used with React.js to build user interfaces and interactive web.

```
"chart.js": "^4.2.1",  
"draft-js": "^0.11.7",  
"moment": "^2.29.4",  
"react": "^18.2.0",  
"antd": "^5.2.2",  
"axios": "^1.3.4",  
"socket.io-client": "^4.6.1",
```

chart.js: This is a JavaScript library for creating responsive and customizable charts and graphs. It provides a range of chart types, such as line, bar, pie, and scatter, and supports animation and interactivity.

draft-js: This is a rich text editor framework for React.js that provides a flexible and extensible way to build text editors with features such as inline styles, block styles, and entity ranges.

moment: This is a JavaScript library for parsing, validating, manipulating, and formatting dates and times. It provides a range of features for working with dates, such as adding or subtracting time, formatting dates, and comparing dates.

react: This is a popular JavaScript library for building user interfaces. It provides a declarative and component-based approach to building UIs, which can make it easier to manage complex applications.

antd: This is a UI library for React.js that provides a range of customizable and responsive components such as buttons, menus, forms, and tables. It also provides a range of icons and themes.

axios: This is a JavaScript library for making HTTP requests from the browser or Node.js. It provides a range of features such as interceptors, cancellation, and error handling.

socket.io-client: This is a JavaScript library for connecting to a Socket.IO server from the client-side (such as a web browser). It provides a range of features for real-time communication between the client and server, such as sending and receiving events.

Overall, these libraries help us to create interactive and engaging front-end applications with React.js, with features such as charts, text editors, dates, UI components, HTTP requests, and real-time communication.

4.1.2 Website

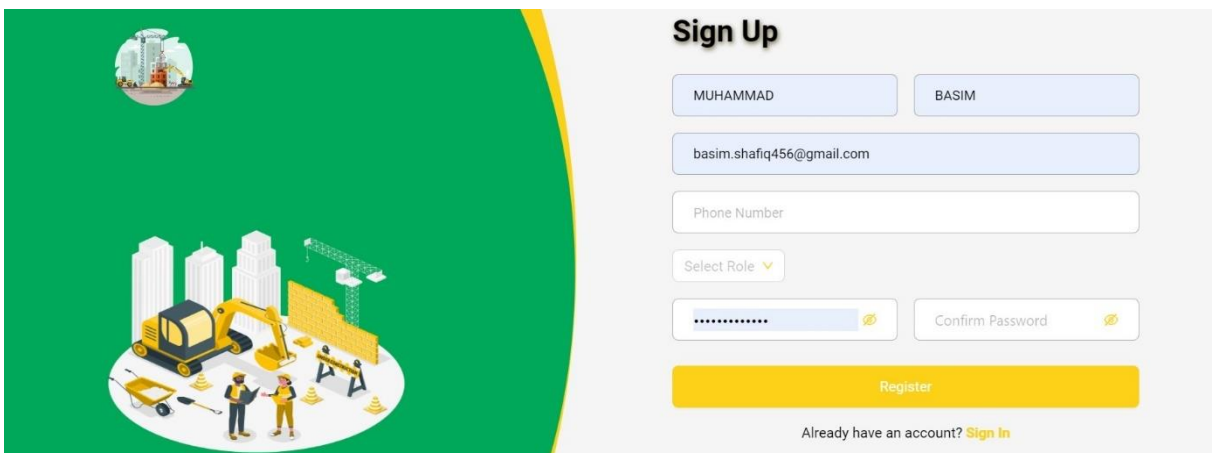


Figure 28

Add New Project ✕

Title

Description

Contractor

Enginner




Figure 29

← PROJECT DETAILS

Title

Description

Figure 30

| | | |
|---|---|---|
|  CLIENT <i>MUHAMMAD BASIM</i> |  CONTRACTOR <i>Nouman Shoukat</i> |  ENGINEER <i>Samran Inshal Ijaz</i> |
|---|---|---|

Progress Details Add New Step

Figure 31

Select Work Step ✕

Select a Step ▼

Description

Type : Document Confirmation

Ask From : CONTRACTOR ENGINEER

Expire In :

Figure 32

Select Work Step ✕

cashFlow ▼

Please submit your Detailed Cash Flow Program

Type : Document Confirmation

Ask From : CLIENT CONTRACTOR

Expire In :

Figure 33

cashFlow

PENDING

Please submit your Detailed Cash Flow

Day 04 : Hour 23 : Min 59 : Sec 07

SelectFile



Figure 34

cashFlow

SUBMITTED

Please submit your Detailed Cash Flow Program

Detailed Cash Flow Programme.pdf



Figure 35

Code

4..1.3.1 Back End Coding

```
projectjs - CivilManagement-SemranFYP - Visual Studio Code [Administrator]
projectjs x
her > model > projectjs > ...
24 const projectSchema = new mongoose.Schema({
25   title: {
26     type: String,
27     required: [true, "Project Title is Required"]
28   },
29   description: {
30     type: String,
31     required: [true, " Project Description is Required"]
32   },
33   status: {
34     type: String,
35     enum: {
36       values: ["cancelled", "rejected", "inprogress", "completed", "active", "pending"],
37       message: "Status must be inprogress, active, completed or pending",
38     },
39     default: "pending",
40     // default: false
41   },
42   client: {
43     type: mongoose.Schema.Types.ObjectId,
44     ref: "user"
45   },
46   engineer: {
47     type: mongoose.Schema.Types.ObjectId,
48     ref: "user",
49     default: null,
50   },
51   contractor: {
52     type: mongoose.Schema.Types.ObjectId,
53     ref: "user",
54     default: null
55   },
56   acceptedBy: {
57     type: Array,
58     default: []
59   },
60 }
```

Figure 36

```
routes.js - CivilM...
routes.js x
Server > constants > routes.js > <unknown>
1 module.exports = {
2   AUTH: `/auth`,
3   USER: `/users`,
4   ADMIN: `/admin`,
5   MODEL: `/model`,
6   PROJECT: `/project`,
7   CHAT: `/chat`,
8 };
9
```

Figure 37

```
router.js - CivilManagement-SamranFYP - Visual Studio C...
router.js x
Server > routes > router.js > ...
1 const express = require("express");
2 const routes = require("../constants/routes");
3 const controllers = require("../controller");
4 const router = express();
5
6 router.use(routes.AUTH, controllers.auth);
7 router.use(routes.ADMIN, controllers.admin);
8 router.use(routes.USER, controllers.user);
9 router.use(routes.PROJECT, controllers.project);
10 router.use(routes.CHAT, controllers.chat);
11
12 module.exports = router;
```

Figure 38

```
Server > index.js > ...
1  const express = require("express");
2  const http = require("http");
3  const path = require("path");
4
5  // Middlewares :
6  const notFound = require("../middlewares/notfound");
7  const cors = require("cors");
8  const morgan = require("morgan");
9  const errorHandler = require("../controller/error/errorhandler");
10
11 // Routes :
12 const router = require("../routes/router");
13 // Models :
14 const MessageModel = require("../model/chat/message");
15 const ChannelModel = require("../model/chat/channel");
16 // DB Connection :
17 require("../config/connection");
18
19 // Ports :
20 const app = express();
21 const PORT = process.env.PORT || 4000;
22
23
24
25
26
27 const server = http.createServer(app);
28 const io = require('socket.io')(server, {
29   cors: {
30     origin: "*",
31   },
32 });
33
34
35 app.use(express.json());
36 app.use(cors());
37 app.use(morgan("dev"));
38 app.use(express.static(path.join(__dirname, './views')));
39 app.use(express.static(path.join(__dirname, './public')));
40 app.get("/", (req, res, next) => {
41   res.sendFile(path.join(__dirname, "/views", "welcome.html"));
42 });
43 app.use("/api", router);
44 app.use(notFound);
45 app.use(errorHandler);
46
47
48 server.listen(PORT, () => console.log(`Server is started at http://localhost:\${PORT}!`));
49
50
51
52 // SOCKETS :
53 io.on('connection', {socket} => {
54   console.log('User connected with ID: ', socket.id);
55
56   socket.on("joinChannel", (channel) => {
57     try {
58       channel.forEach((channel) => {
59         socket.join(channel);
60         console.log('Channel joined');
61       });
62     } catch (e) {
63       console.log('error: ' + e);
64     }
65   });
66
67   socket.on('joinUserRoom', (user_id) => {
68     try {
69       socket.join(user_id);
70       console.log('user room joined');
71     } catch (e) {
72       console.log('error: ' + e);
73     }
74   });
75
76
77
78
79
80
81
82
83
84
85
86
87
88
89
90
91
92
93
94
95
96
97
98
99
100
```

Figure 39

```

ver > controller > projectDetail > project.js > ...
const express = require("express");

const ProjectModel = require("../model/project");

const catchAsync = require("../utils/catchAsync");
const { CreateChannelByProject } = require("../helper/chat");
const STATUS_CODE = require("../constants/statusCode");
const { uploadFile } = require("../utils/suploader");
const sendEmail = require("../utils/emails/sendEmail");

exports.projectGet = catchAsync(async (req, res) => {
  try {
    let currentUser = req.user;
    const result = await ProjectModel.find({ [currentUser.role]: currentUser._id }).populate("client contractor engineer").populate({ path: "progress", select: "by from" });
    res.status(STATUS_CODE.OK).json({ result, message: "Data Fetched Success Fully" });
  } catch (err) {
    res.status(STATUS_CODE.BAD_REQUEST).json({ statusCode: STATUS_CODE.SERVER_ERROR, err })
  }
})

exports.getProjectById = catchAsync(async (req, res) => {
  try {
    let currentUser = req.user;
    let { projectId } = req.params;
    const result = await ProjectModel.findById(projectId).populate("client contractor engineer").populate({ path: "progress", populate: "by from" });
    console.log("----->", result);
    res.status(STATUS_CODE.OK).json({ result, message: "Data Fetched Success Fully" });
  } catch (err) {
    res.status(STATUS_CODE.BAD_REQUEST).json({ statusCode: STATUS_CODE.SERVER_ERROR, err })
  }
})

exports.projectPost = catchAsync(async (req, res, next) => {
  const currentUser = req.user;
  const data = req.body

  data.client = currentUser?._id

  try {
    const newData = new ProjectModel(data)
    await newData.save()
    await newData.populate("client contractor engineer")

    let name = newData.title;
    let projectId = newData._id;
    let users = [newData.client?._id, newData.contractor?._id, newData.engineer?._id];
    let channelResult = await CreateChannelByProject({ name, users, projectId, currentUser }, next)

    sendEmail(`${newData.contractor?.email}, ${newData.engineer?.email}`, newData, next)

    res.status(STATUS_CODE.OK).json({ message: "Project Created Successfully", result: newData, channelResult })
  } catch (err) {
    res.status(STATUS_CODE.SERVER_ERROR).json({ statusCode: STATUS_CODE.SERVER_ERROR, err })
  }
})

exports.inviteResponse = catchAsync(async (req, res, next) => {
  let { response, projectId } = req.body;

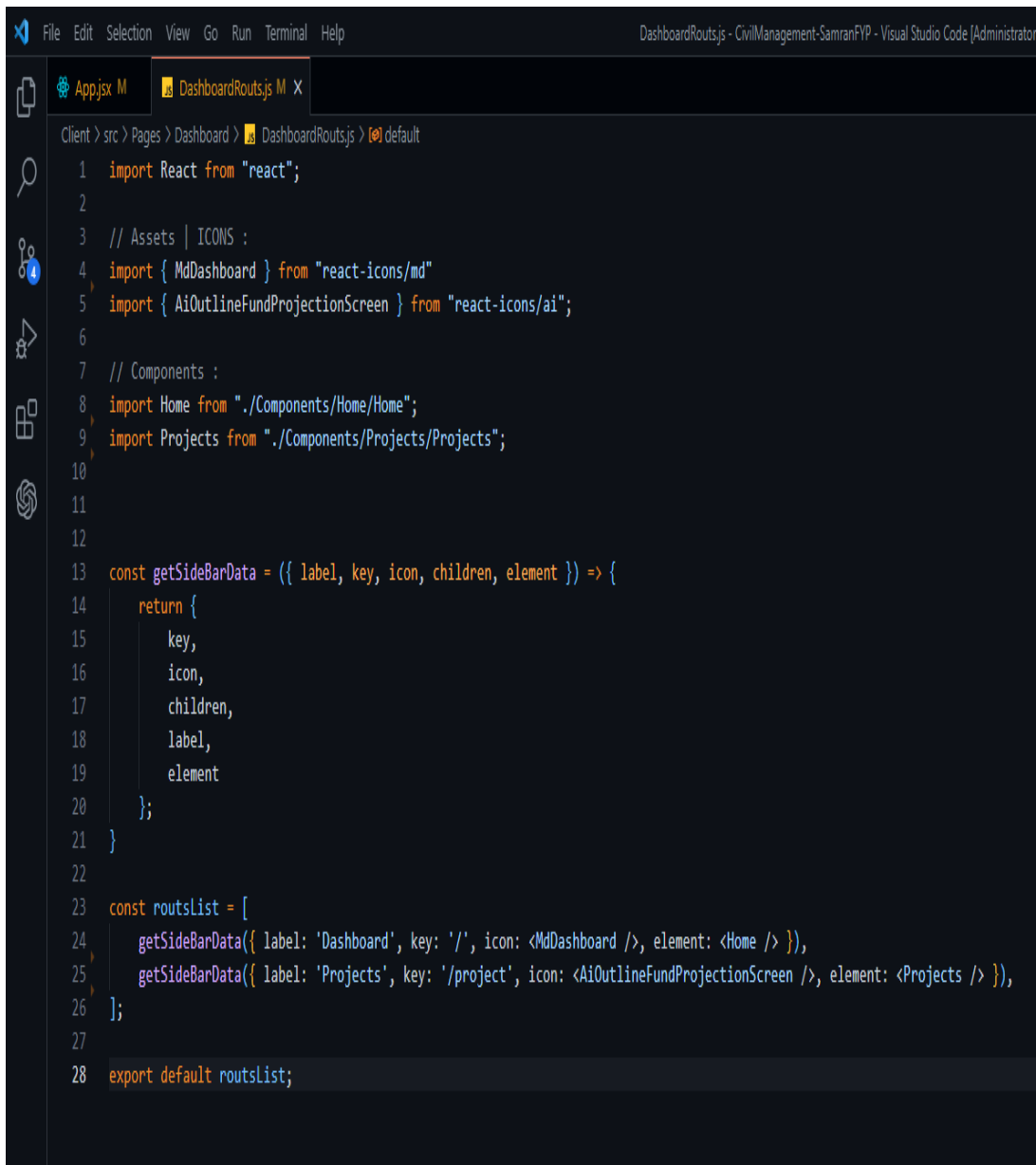
  const currentUser = req.user

  try {
    const projectData = await ProjectModel.findById(projectId)
    if (response == "reject") {
      projectData.status = "rejected"
      projectData.rejectedBy = currentUser?._id
    } else {
      projectData.acceptedBy = [...projectData.acceptedBy, currentUser?._id]
      if (projectData.acceptedBy?.includes("contractor") && projectData.acceptedBy?.includes("engineer")) {
        projectData.status = "inprogress"
      }
    }
    await projectData.save()
    res.status(STATUS_CODE.OK).json({ message: "Invite Updated", result: projectData })
  } catch (err) {
    res.status(STATUS_CODE.SERVER_ERROR).json({ statusCode: STATUS_CODE.SERVER_ERROR, err })
  }
})

```

Figure 40

4..1.3.2 Front End Coding



```
Client > src > Pages > Dashboard > DashboardRoutes.js > default
1  import React from "react";
2
3  // Assets | ICONS :
4  import { MdDashboard } from "react-icons/md"
5  import { AiOutlineFundProjectionScreen } from "react-icons/ai";
6
7  // Components :
8  import Home from "./Components/Home/Home";
9  import Projects from "./Components/Projects/Projects";
10
11
12
13  const getSideBarData = ({ label, key, icon, children, element }) => {
14    return {
15      key,
16      icon,
17      children,
18      label,
19      element
20    };
21  }
22
23  const routsList = [
24    getSideBarData({ label: 'Dashboard', key: '/', icon: <MdDashboard />, element: <Home /> }),
25    getSideBarData({ label: 'Projects', key: '/project', icon: <AiOutlineFundProjectionScreen />, element: <Projects /> }),
26  ];
27
28  export default routsList;
```

Figure 41

```
Client > src > Pages > Dashboard > Components > Projects > Projects.jsx > ...
4   import { Button, Tag } from 'antd';
5
6   // Assets | Icons :
7   import { GrView } from "react-icons/gr";
8   import { MdDelete } from "react-icons/md";
9
10  // Components :
11  import Table from "../Component/table/Table";
12  import AddNewProject from "../Component/AddProjectModal/NewProjectModal";
13  import AllProject from "../Component/AllProjects/AllProjects";
14  import ViewProjectPage from "../Component/ViewProject/ViewProjectPage";
15  import ChatApp from "../ChatApp/index";
16
17  // API :
18  import { GetAllProjectsAPI } from "../../../../../API/project";
19  // Helpers :
20  import { toast } from "react-toastify";
21
22  // CSS :
23  import "../Projects.scss";
24
25
26
27
28
29  const Projects = () => {
30
31    const [allProjects, setAllProjects] = useState([])
32    const [currentPage, setCurrentPage] = useState("all")
33    const [selectedProject, setSelectedProject] = useState(null)
34
35
36    const closeModal = () => {
37      setCurrentPage("details")
38    }
39
40    return (
41      <>
42        <div className="dashboardProjectContainer">
43          {
44            currentPage == "all" ?
45              <AllProject allProjects={allProjects} setAllProjects={setAllProje
46                : currentPage == "chat" ?
47                  <ChatApp openModal={currentPage == "chat" ? true : false} sel
48                    :
49                  <ViewProjectPage selectedProject={selectedProject} setCurrent
50                }
51            </div>
52          </>
53        )
54      }
55
56  export default Projects
```

Figure 42

```

47 const gettingAllMessages = async (page) => {
48   try {
49     setMessagesLoading(true);
50     setLoading(false);
51     const res = await GetAllMessagesByChannelAPI(selectedChat?.channelId, page);
52     if (res.error != null) {
53       toast.error(res.error)
54       return
55     }
56     let messagesData = res.data?.result
57     let pagination = res.data?.pagination
58     console.log("*****", res.data);
59     handleAddPage();
60     paginationRef.current = pagination;
61     setMessages(messagesData);
62   } catch (error) {
63     console.log({ error });
64   } finally {
65     setMessagesLoading(false);
66   }
67 }
68
69 const handleScroll = async (e) => {
70   try {
71     const post = e.target.scrollTop;
72     if (

```

Figure 43

```
App.jsx M | DashboardRoutes.js M | Projects.jsx | Chat.js X
Client > src > Pages > Dashboard > Components > ChatApp > Chat.js > Chat > gettingAllMessages
1 import React, { useEffect } from "react";
2 import { useNavigate, useLocation } from "react-router-dom";
3
4 // MUI | ANT-D :
5 import { Grid, Box, IconButton, Typography, useTheme, Tooltip, useMediaQuery, Backdrop, CircularProgress, Button, } from "@mui/material";
6 import ArrowBackIcon from "@mui/icons-material/ArrowBack";
7
8 // Components :
9 import UserAvatar from "./UserAvatar";
10 import ChatHistory from "./ChatHistory";
11 import MessageInput from "./MessageInput";
12 // import MainCard from "../shared/MainCard";
13
14 // APIs :
15 import { GetAllMessagesByChannelAPI } from "API/chat";
16 // Redux :
17 import { useSelector } from "react-redux";
18 // Helpers :
19 import { toast } from "react-toastify";
20 import { socket } from "Utils/sockets";
21
22 // CSS :
23 import styles from "./style";
24
25
26
27
28
29
30 const Chat = ({ selectedChat, setSelectedChat, messagesLoading, setMessagesLoading, selectedChannel, setSelectedChannel, pageRef, handleAddPage }) => {
31   const navigate = useNavigate();
32   const { state } = useLocation();
33
34   const UserData = useSelector(state => state.userData);
35
36   const theme = useTheme();
37   const mobile = useMediaQuery(theme.breakpoints.down("md"));
38
39   const [scrollToBottom, setScrollToBottom] = React.useState(false);
40   const [messages, setMessages] = React.useState([]);
41   const [loading, setLoading] = React.useState(false);
42   const [appendMsg, setAppendMsg] = React.useState({});
43   const paginationRef = React.useRef();
44   const toastId = React.useRef(null);
45
```

Figure 44


```

Client > src > App.jsx > App > gettingProfileData
9
10 // API :
11 import { GetProfileAPI } from "API/user"
12 // Redux :
13 import { useDispatch } from "react-redux";
14 import { userDataActions } from "Redux/Slice/userData"
15 // Helpers :
16 import { ToastContainer } from "react-toastify";
17
18 // CSS :
19 import './App.scss';
20 import 'react-toastify/dist/ReactToastify.css';
21
22
23
24
25
26 const ProtectedRoute = ({ user, children }) => {
27   if (!user) {
28     return <Navigate to="/login" replace />;
29   }
30
31   return children;
32 };
33 const App = () => {
34   const Dispatch = useDispatch()
35   let token = localStorage.getItem("civilToken")
36   let AuthToken = token ?? null
37
38   const gettingProfileData = async () => {
39     let res = await GetProfileAPI()
40     if (res.error != null) {
41
42     } else {
43       let userData = res.data.result
44       userData.token = AuthToken
45       Dispatch(userDataActions.setUserData(userData))
46       localStorage.setItem("civilUserData", JSON.stringify(userData))
47
48     }
49   }
50   if (AuthToken) {
51     gettingProfileData()
52   }
53

```

Figure 45

```

return (
  <ToastContainer
    position="top-right"
    autoClose={2000}
    hideProgressBar={true}
    newestOnTop={false}
    closeOnClick
    rtl={false}
    pauseOnFocusLoss
    draggable
    pauseOnHover
    theme="dark"
  />
  <Routes>
    <Route path='login' element={<Login />} />
    <Route path='register' element={<Register />} />
    <Route path='dashboard/*' element={<ProtectedRoute user={AuthToken}> <Dashboard /> </ProtectedRoute>} />
    <Route path='*' element={<Navigate to="/dashboard" replace />} />
  </Routes>
</>
);
}

export default App;

```

Figure46

5. Conclusion and Recommendation

Our research tool is based on FIDIC 1987, 1992 Redbook version and PEC standard bidding documents. Further latest versions of FIDIC and also JCT, NEC, AIA, EJCDC, GC21, JBCC contracts can also be used for research projects. Also using further addition of VR or AR in website could help stakeholders visualize construction plans and changes and get a more immersive experience of the project.

Implementing AI and ML in websites could help stakeholders identify and mitigate risks in real-time and could even help predict project outcomes. This could assist to keep the project on schedule and under budget.

BIM is a 3D model-based process that can help streamline the construction process by providing detailed information about the project. Integrating BIM with website could help stakeholders easily access and collaborate on BIM data.

Blockchain is a secure and transparent technology that could be used to track changes and updates in project documentation, ensuring that all stakeholders have access to the most up-to-date information. This could help prevent disputes and misunderstandings that could arise due to miscommunication.

Support for multiple languages on this website could help stakeholders who speak different languages to collaborate effectively. This could be especially helpful for projects that involve teams from different countries.

Integrating supply chain management tools into the website could help stakeholders oversee the transportation of supplies and machinery to the building location. This could help make sure that the project stays on schedule and that materials are available when needed.

Incorporating voice recognition technology into the website could help stakeholders enter information and communicate with each other more easily. This could be especially helpful for stakeholders who are working on the construction site and have their hands full.

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