Construction Site Database Management

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Mann Shrimali 202412046
Smit Thakkar 202412116

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Professor: Minal Bhise

Dhirubhai Ambani Institute of Information and Communication Technology

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Chapter 1: Software Requirements Specification (SRS)

Problem Statement

Overview

The Construction Industry, particularly civil engineering, involves building and assembling infrastructure. Large-scale construction requires multitasking, and the industry faces increasing project risks and complexity. Long-term contracts and post-construction services present both challenges and opportunities.

Market Size: The construction industry is one of the largest globally, valued at approximately 10 trillion USD.

Economic Impact: It significantly contributes to national economies and employs a vast workforce.

Project Complexity: With growing project sizes and demands for quicker delivery, the coordination between contractors, suppliers, and stakeholders becomes more challenging. Projects often involve multiple disciplines working simultaneously, from initial design to final handover.

Long-Term Contracts: The shift towards long-term contracts and post-construction services has created new opportunities for innovation in construction management. However, it also introduces risks related to maintenance and operational costs that must be factored into the initial planning stages.

Technological Advancements: With the rise of technology integration such as Building Information Modeling (BIM), drones, and AI, companies are finding new ways to streamline workflows and reduce project timelines, while minimizing waste and error.

Purpose

The Construction Site Management Database is designed to centralize all critical information necessary for managing construction projects. It offers:

Monitoring Tools for measurements, materials (e.g., concrete, steel), and construction designs, ensuring availability and adherence to required standards.

Financial Tracking for costs and budgets to prevent overspending.

Quality Assurance through regular checks, ensuring compliance with construction standards.

Communication & Coordination tools that enhance collaboration among project participants for more organized and timely decision-making.

Intended Audience

1. **Construction Manager**: Oversees the execution of construction projects, ensuring they meet deadlines, budgets, and quality standards.
2. **Construction Accountants**: Manages financial transactions, budget allocations, and audits related to construction projects.
3. **Finance Managers**: Controls financial planning and tracks costs to ensure project profitability and proper resource allocation.
4. **Logistics Managers**: Coordinates the transportation, storage, and supply of materials and equipment for construction sites.
5. **Inventory Managers**: Oversees material availability, procurement, and stock levels to prevent project delays.
6. **Project Analysts**: Provides data-driven insights to improve project efficiency, track performance, and minimize risks.
7. **Architects / Building Designers**: Designs functional, safe, and aesthetically pleasing buildings, integrating structural and material considerations.
8. **Quality Control Analysts / Testers**: Ensures that construction materials and processes meet safety and quality standards through regular inspections.
9. **Construction Workers**: Carries out hands-on construction tasks, implementing project plans under the supervision of site managers.

Product Scope

The **Product Scope** of our construction site management database includes centralizing all critical information for managing construction projects. This encompasses:

- **Project Management:** Tracking project details, timelines, budgets, and execution phases.
- **Material & Equipment Tracking:** Managing inventory, material suppliers, tool usage, and availability.
- **Financial Oversight:** Monitoring budgets, costs, and payment statuses.
- **Risk & Safety Management:** Tracking accidents, safety protocols, inspections, and risk assessments.
- **Quality Control:** Ensuring compliance through quality checks, standards, and inspections.
- **Collaboration & Communication:** Facilitating coordination between stakeholders, contractors, and workers.

Problem Description

An industry as big as construction requires a proper management system because its complexity can easily be overlooked and can easily get too big to manage.

Tracking the measurements, material like concrete and steel, and construction designs, ensuring everything needed for the project is available on time and that the work meets the required standards becomes really important. In spite of the steady rise of the construction industry and its demand, it remains heavily dependent on manual labor. The construction industry faces challenges that become even more for developing countries.

During our comprehensive fact-finding process aimed at understanding the operations of a construction site, we employed a multi-faceted approach to gather insights into the challenges and intricacies faced by site managers and workers. This investigation included background research, the distribution of a detailed questionnaire, and an in-depth interview with key personnel. The findings provide a clearer understanding of the day-to-day complexities involved in managing a construction site, highlighting both operational and human resource challenges.

Some key challenges are poor productivity, inflation, and rising costs, availability of skilled labor and increased competition, and shrinking profit margins.

One key focus is on estimating costs, setting project budgets, and handling contingencies. It becomes important to use practical methods to ensure that budgets remain on track, and includes strategies for avoiding common pitfalls related to underestimating project costs.

There is a need to implement robust systems to ensure that construction meets required standards without excessive rework or delays.

From the background readings, it became evident that the management of construction projects involves a delicate balance of planning, coordination, and execution. Site managers are tasked with overseeing project timelines, resource allocation, and adherence to safety regulations, while also ensuring smooth communication among different stakeholders. The complexity is further heightened by the need to anticipate and mitigate unforeseen issues, such as equipment malfunctions, supply delays, and weather disruptions.

These factors contribute to the multifaceted nature of the role, requiring strong leadership and problem-solving abilities.

An integral part is in-depth discussions on organizing project teams, outlining responsibilities, and maintaining effective communication across stakeholders. Additionally, it emphasizes the importance of proper documentation, including contracts, project reports,etc.

There are safety concerns in construction—fall hazards. It’s important to identify the primary causes of falls on construction sites and outline the most effective strategies to mitigate these risks. Factors contributing to falls include poor site conditions, lack of proper safety equipment, insufficient training, and inadequate safety protocols. Construction workers are frequently exposed to heights and unstable structures, leading to a higher risk of falls.

Effective safety management systems, regular inspections, and training are essential to prevent accidents and ensure worker well-being. Risk management is also crucial, as construction projects are vulnerable to unexpected delays and cost overruns.

Inventory Management systems consist of different tasks like finding suitable materials, procurement process of those materials, transportation. Materials on construction sites cost around 50-60% of the total cost of the project, so it becomes very crucial to handle the materials methodically.

Construction projects are vulnerable to unexpected risks, which can cause delays, cost overruns, or even project failure if not managed properly. It means a structured approach for identifying and assessing risks, including steps like knowledge acquisition, team selection, and verification.

Requirement Collection

Background Readings

1. **Information Technology in Construction: Domain Definition and Research Issues**
    - **Type:** Research Journal
    - **Author:** Bo-Christer Björk
    - **Publication:** *International Journal of Computer Integrated Design and Construction* (May 1999)
    - **Citation:** Information technology in construction: domain definition and research issues

Key Points:

- The author, Mr. Björk, believes there is a need for a discussion of 'Information Technology in Construction' as a discipline, possibly leading to some degree of consensus among leading researchers on the scope and scientific methodology of the discipline.
- In spite of the steady rise of the construction industry and its demand, it remains heavily dependent on manual labor. The construction industry faces challenges that become even more for developing countries.
- Some key challenges are poor productivity, inflation, and rising costs, availability of skilled labor and increased competition, and shrinking profit margins.
- An abstract formalized model of information management in construction is proposed as the basis for a definition of the domain and boundaries of ITC.

2. Project Management in Construction (7th Edition)

- **Type:** Research Journal
- **Author:** Sidney M Levy
- **Citation:** *Levy, Sidney (2018). Project management in construction (7th ed.). McGraw-Hill Education*.

Key Points:

- The book is a comprehensive guide aimed at professionals involved in construction project management. It focuses on the core goal of controlling **quality**, **schedules**, and **costs** throughout the life cycle of a project.
- **Complex Construction Processes:** It provides insight into how construction projects, which are typically complex and multifaceted, can be managed more efficiently by following well-defined processes.
- **Estimating and Budgeting:** One key focus is on **estimating costs**, setting project budgets, and handling contingencies. The book discusses practical methods to ensure that budgets remain on track, and includes strategies for avoiding common pitfalls related to underestimating project costs.
- **Quality Control and Assurance:** A significant portion of the book is dedicated to **quality assurance** and **quality control** (QA/QC). These sections guide the reader on implementing robust systems to ensure that construction meets required standards without excessive rework or delays.
- **Team Management and Documentation:** Levy also provides in-depth discussions on organizing project teams, outlining responsibilities, and maintaining effective communication across stakeholders. Additionally, it emphasizes the importance of **proper documentation**, including contracts, project reports,etc.

3. **An Appraisal into the Potential Application of Big Data in the Construction Industry**
    - **Type:** Research Journal
    - **Authors:** Siti Aisyah Ismail, Shamsulhadi Bandi, Zafira Nadia Maaz
    - **Publication:** *International Journal of Built Environment and Sustainability* (April 2018)

    - **Key Points:**
        - **Big Data in Construction:** The paper explores how **Big Data** can be leveraged in the construction industry to improve decision-making, project management, and overall efficiency.
        - **Data-Driven Insights:** With the use of Big Data analytics, construction managers can gain real-time insights into various project metrics such as resource allocation, equipment usage, and task performance, leading to improved planning and execution.
        - **Predictive Maintenance:** The integration of Big Data allows for **predictive maintenance** of machinery and equipment, reducing downtime and preventing costly repairs by identifying potential failures before they occur.
        - **Risk Management:** Big Data enhances **risk management** by enabling better identification of potential risks based on historical data, which helps in the formulation of more accurate risk mitigation strategies.
        - **Challenges in Data Collection:** Despite the benefits, the research highlights several challenges in data collection on construction sites, including inconsistent data sources, integration difficulties, and the need for skilled personnel to manage data effectively.
        - **Future Applications:** The paper calls for further research into how **Machine Learning** and technologies can be applied in construction automating tasks like scheduling, risk prediction, and resource management.

4. Causes of Fall Hazards in Construction Site Management

- **Type:** Research Paper
- **Authors:** Chong Hui Liy, Siti Halipah Ibrahim, Rohaida Affandi, Nor Azalina Rosli, Mohd Nasrun Mohd Nawi
- **Publication:** *International Review of Management and Marketing* (October 2016)
- **Key Points:**
    - **Overview of Fall Hazards:** This paper addresses one of the most serious safety concerns in construction—**fall hazards**. It identifies the primary causes of falls on construction sites and outlines the most effective strategies to mitigate these risks.
    - **Risk Factors:** Factors contributing to falls include poor site conditions, lack of proper safety equipment, insufficient training, and inadequate safety protocols. Construction workers are frequently exposed to heights and unstable structures, leading to a higher risk of falls.
    - **Regulations and Enforcement:** The study emphasizes the importance of **enforcing safety regulations** and standards. It highlights the need for project managers to strictly implement safety measures, conduct regular inspections, and ensure compliance with legal safety requirements.
    - **Training and Awareness:** One of the key recommendations is to provide **comprehensive training** for workers on how to use safety equipment and follow fall-prevention protocols. Regular safety drills and **awareness campaigns** can also help reduce the occurrence of falls.
    - **Effective Safety Systems:** The paper advocates for implementing an **effective safety management system** that includes frequent workplace inspections, monitoring of potential hazards, and a system for reporting and addressing safety concerns.

5. Inventory Management in Construction Industry

- **Type:** Research Paper
- **Authors:** Harsh Malik and Pushpendra Kumar Sharma
- **Originally Published** : May, 2022
- **Citation** : Malik, H., & Sharma, P. K. (2022). Inventory Management in Construction Industry. *IOSR J. Eng*, *12*(5), 26-33.
- **Key Points:**
    - It's really important at a construction site that all the required raw materials are readily available on time and meet the required standards. Inventory Management systems consist of different tasks like finding suitable materials, procurement process of those materials, transportation. Materials on construction sites cost around 50-60% of the total cost of the project, so it becomes very crucial to handle the materials methodically.
    - The main objective of this paper is to study the existing research on inventory management in the Indian construction industry to observe the importance of inventory management and different costs associated with.
    - This research paper looks into all the studies that have been done around the topic of inventory management and provides us with findings with each one of them.

6. The Controlling Influences on Effective Risk Identification and Assessment for Construction Design Management

- **Type:** Research Paper
- **Author:** Robert J. Chapman
- **Publication:** *International Journal of Project Management* (April 2001)
- **Citation** :Chapman, R. J. (2001). The controlling influences on effective risk identification and assessment for construction design management. *International journal of project management*, *19*(3), 147-160.
- **Key Points:**
    - **Risk in Construction Projects:** Construction projects are vulnerable to unexpected risks, which can cause delays, cost overruns, or even project failure if not managed properly.
    - **Risk Identification Process :** The paper outlines a structured approach for identifying and assessing risks, including steps like **knowledge acquisition**, **team selection**, and **verification**.
    - **Consequences of Poor Risk Management :** Failure to manage risks can result in major threats to project goals, affecting both financial and operational outcomes.
    - **Recommendations :** Emphasizes a **comprehensive risk management strategy** that ensures thorough risk assessment and effective communication among stakeholders to minimize risks.

7. Coordinated construction logistics: an innovation perspective

- **Type:** Research Paper
- **Authors:** S Hedborg Bengtsson
- **Originally Published** : November, 2018
- **Citation** : Hedborg Bengtsson, S. (2018). Coordinated construction logistics: an innovation perspective. *Construction Management and Economics*, *37*(5)
- **Key Points:**
    - All the logistics for a construction firm be it for a project or group of projects has to be coordinated in order to get full efficiency out of all the resources.
    - Construction projects are complex, it was concluded 50 years ago in the study of distribution of house-building material, saying that *"the number of possible permutations and combinations of specific places and entities is enormous, even for one product"*. This complexity is often used in supply chain management as an argument for construction projects to implement more structured and coordinated construction logistics models.
    - This calls the need for different models for different requirements. This paper formulates by categorizing the explored models as different types of innovation, the main practical implication is for management to understand that, depending on context and number of involved actors, different models will suit different organizations, projects and systems. Where an inter-organizational context seems to require unified management, actors engagement and clear directives. If these factors are not present, the innovation runs the risk of not being embedded.

8. Big Data in the construction industry: A review of present status, opportunities, and future trends

- **Type:** Research Article
- **Author:** Muhammad Bilala, Lukumon O. Oyedele and More
- **Originally Published** : July, 2016
- **Citation** : Big Data in the construction industry: A review of present status, opportunities, and future trends (sciencedirectassets.com)

Key Points:

- **Key-value**: This is the simplest data model to store unstructured data. However, the underlying data is not self-describing.
- **Document**: This data model is suitable for storing self describing entities. However, the storage of this model can be inefficient.
- **Columnar**: This data model favors the storage of sparse data sets, grouped sub-columns, and aggregated columns.
- **Graph**: This is a relatively new data model that supports relationship traversal over a huge dataset of property-graphs. Graph databases are getting more popular than other data models,

The Key Points from the Conclusion of the paper

- **Big Data Potential**: Big Data has significant potential to revolutionize the construction industry by improving efficiency and decision-making.
- **Current Adoption**: The adoption of Big Data technologies in the construction industry is still in its early stages and lags behind other industries.
- **Challenges**: There are several challenges to Big Data adoption, including data integration, data quality, and the need for skilled personnel.
- **Opportunities**: Big Data can provide opportunities for resource optimization, waste reduction, and enhanced project management.
- **Machine Learning**: Machine learning techniques can be applied

to various construction processes for predictive analytics and automation.

- **Data Analytics**: Advanced data analytics can help in identifying patterns and trends, leading to better decision-making.
- **Interdisciplinary Approach**: An interdisciplinary approach is essential for the successful implementation of Big Data in construction.
- **Future Research**: There is a need for more research to address the open issues and explore the full potential of Big Data in construction.
- **Technological Advancements**: Continuous technological advancements are necessary to overcome the current limitations and enhance Big Data applications.
- **Collaboration**: Collaboration between academia, industry, and government is crucial for the successful adoption of Big Data technologies in the construction industry.

9. Projecting capitalism: a history of the internationalization of the Construction Industry

- **Type:** Book
- **Author:** Marc Linder
- **Originally Published** : 1994
- **Citation** : Projecting capitalism: a history of the internationalization of the construction industry - Projecting capitalism: a history of the internationalization of t - University of Iowa (uiowa.edu)

Key Points:

- **Historical Context**: The construction industry has long been a cornerstone of economic development, dating back to ancient civilizations. Over time, it has evolved from small-scale, localized operations to a highly complex and internationalized sector. This transformation was driven by technological advancements, economic demands, and the need for infrastructure to support growing populations and industries.
- **Internationalization**: The internationalization of the construction industry began in earnest during the 19th and 20th centuries. European and American companies started to take on projects in foreign countries, driven by the pursuit of new markets and resources.
- **Modern Developments**: In recent decades, the construction industry has continued to globalize, with companies from emerging economies also entering the international arena. The industry now faces new challenges and opportunities, including sustainability concerns, technological innovations like Building Information Modeling (BIM), and the need for resilient infrastructure in the face of climate change.

10. Factors Influencing Construction Ergonomic Performance in India

- **Type:** Research Paper
- **Authors:** Ratri Parida, Pradip Kumar Ray
- **Publication:** *Procedia Manufacturing* (2015)
- **Citation** : Factors Influencing Construction Ergonomic Performance in India - ScienceDirect

Key Points:

- **Ergonomic Performance:** Construction workers in India often face poor working conditions, leading to injuries that impact productivity. The paper focuses on **ergonomic issues** related to man-machine interaction.
- **Factors Impacting Performance:** The study identified 30 critical factors influencing ergonomic performance, classified into three categories:
  - **Human/Labor-Related Factors**: Includes body joint discomfort in masons, helpers, and carpenters.
  - **Task-Related Factors**: Repetitive work, lack of rest, and awkward postures.
  - **Equipment-Related Factors**: Difficulty handling heavy tools and improper tool design.
- **Survey Analysis:** Based on a survey of 220 construction workers, the **Relative Importance Index (RII)** was used to rank the factors by their impact on performance.
- **Recommendations:** The study suggests applying ergonomic principles to reduce **musculoskeletal disorders** (MSDs) and improve overall safety and comfort on construction sites.

Interview

Skyline Constructions: Interview Plan

Project: Caledonia Avenue

Project Reference: SC/RC/2024/19

Participants: Darsh Jain (Skyline Constructions, Caledonia Site Manager)
Smit Thakkar (Interviewer)
Mann Shrimali (Interviewer)

Date: 10/09/2024 **Time:** 11 am

Duration: 60 minutes **Place:** Darsh's Office

Purpose of Interview:
Meeting the construction site project manager to get the idea of what processes go into a large scale construction project and what are the minimum requirements of materials and labor force and other overlooked things that go into a project finishing efficiently..

Agenda:

First hand insights from an experienced personal about the ins and outs of all the complexities that go into a big project.
-> How the requirement of raw materials is managed throughout the project.
-> How the quality assurance is carried out.
-> How they ensure better coordination and decision making.

Documents to be brought to the interview:
Any document relating to a project similar like the one in question
Journal findings about planning of a construction project.

Skyline Constructions: Interview Summary

Project: Caledonia Avenue

Project Reference: SC/RC/2024/19

Participants: Darsh Jain (Skyline Constructions, Caledonia Site Manager)
Smit Thakkar (Interviewer)
Mann Shrimali (Interviewer)

Date: 10/09/2024 **Time:** 11 am

Duration: 60 minutes **Place:** Darsh's Office

Purpose of Interview:
Meeting the construction site project manager to get the idea of what processes go into a large scale construction project and what are the minimum requirements of materials and labor force and other overlooked things that go into a project finishing efficiently..

Interview Summary

1. Raw material requirements are projected before the project starts and it's usually right because they take all the factors into account.
2. No advanced construction site management database in place as such, though an informal and fairly effective system does exist.
3. The finance and budget accounts are managed professionally.
4. Hierarchical type of management functions at the site. All the workers report to their immediate boss.
5. Regular inspections of the site by the project manager and site manager are done to keep the quality at the standard level.
6. The schedule is regularly updated to keep the initial desired timeline intact.
7. A system is in place to ensure there isn't overspending.

Questionnaire

1. How Many Days a Week do you work on a Construction Site?
A. 1-2 Days B. 3-4 Days C.4-5 Days D. 6-7 Days

2. How Would You Describe the Safety Measures on the Construction Site?
A. Satisfactory B. Somewhat Satisfied C. Needs Improvement
D. Hazardous

3. How would you Describe your Raw Material Supply and Quantity?
A. Adequate Quantity B. More than Necessary C. Less than Requirement
D. Always Insufficient

4. How would you Describe the Quality of the Raw Materials?
A. Best Quality B. Standard Quality C. Poor Quality D. Hazardous

5. How would you Describe the availability of the Construction Worker?
A. Adequate Quantity B. More than Necessary C. Less than Requirement
D. Always Insufficient

6. What is the frequency of Safety Checks and Drills on the Site?
A. Daily B. Frequent C. Weekly D. Rarely

7. What Type of Projects do you work on often?
A. Commercial B. Government C. Private D. Personal

8. How would you Describe your Wages and the frequency of Bonuses?
A. Satisfactory B. Somewhat Satisfied C. Needs Improvement
D. Immediate Raise Required

9. What Improvements would you like to suggest regarding the current inspection system?

Your Name _____ Thank you for completing this questionnaire

Observations

During our comprehensive fact-finding process aimed at understanding the operations of a construction site, we employed a multi-faceted approach to gather insights into the challenges and intricacies faced by site managers and workers. This investigation included background research, the distribution of a detailed questionnaire, and an in-depth interview with key personnel. The findings provide a clearer understanding of the day-to-day complexities involved in managing a construction site, highlighting both operational and human resource challenges.

From the **background readings**, it became evident that the management of construction projects involves a delicate balance of planning, coordination, and execution. Site managers are tasked with overseeing project timelines, resource allocation, and adherence to safety regulations, while also ensuring smooth communication among different stakeholders. The complexity is further heightened by the need to anticipate and mitigate unforeseen issues, such as equipment malfunctions, supply delays, and weather disruptions. These factors contribute to the multifaceted nature of the role, requiring strong leadership and problem-solving abilities.

Here is an observation Summary from Background Readings on Construction Site Management:

The background readings provide a comprehensive view of the challenges, advancements, and practices involved in managing construction sites. Several key themes emerge, each contributing to a deeper understanding of the complexities of construction site management.

A. Project Complexity and Coordination:

The construction industry faces growing complexity due to larger project sizes and the need for quicker delivery. This complexity is amplified by the coordination required among contractors, suppliers, and stakeholders. Different disciplines often work simultaneously from initial design to final handover, requiring efficient management strategies. The shift towards long-term contracts adds another layer of complexity, as post-construction services and maintenance must be considered early in project planning.

B. Technological Integration:

Technological advancements such as Building Information Modeling (BIM), drones, AI, and Big Data are reshaping the construction industry. These innovations streamline workflows, reduce errors, and improve decision-making. However, the adoption of these technologies, especially Big Data, is still in its early stages, and the industry faces challenges like data integration, quality issues, and the need for skilled personnel. Nevertheless, these tools hold immense potential for improving efficiency, resource optimization, and predictive maintenance.

C. Safety and Risk Management:

Safety is a critical concern in construction, particularly regarding fall hazards and the need for ergonomic improvements. Effective safety management systems, regular inspections, and training are essential to prevent accidents and ensure worker well-being. Risk management is also crucial, as construction projects are vulnerable to unexpected

delays and cost overruns. Proper risk identification and assessment strategies can help mitigate these risks, ensuring projects stay on track and within budget.

D. Inventory and Financial Management:

Managing inventory and controlling project costs are central to successful construction site management. Materials often represent a significant portion of the total project cost, making it essential to handle procurement and transportation efficiently. Financial tracking tools are critical for preventing overspending and ensuring that budgets are maintained throughout the project lifecycle. Quality control and assurance mechanisms further ensure that materials and processes meet required standards, minimizing rework and delays.

E. Human Resource and Team Management:

The importance of team management, communication, and documentation is highlighted in several readings. Organizing project teams, clearly defining responsibilities, and maintaining effective communication across stakeholders are vital for smooth project execution. Additionally, ergonomic performance, particularly in developing countries, is a growing concern, with poor working conditions and equipment design impacting productivity and worker health.

In conclusion, the readings highlight the dynamic nature of construction site management, emphasizing the need for robust management strategies, technological integration, risk mitigation, and a strong focus on safety and quality to address the industry's evolving challenges.

The **questionnaire responses** from workers revealed a range of operational challenges, including task allocation, workload management, and the physical demands of the job. Workers frequently highlighted the importance of effective communication between management and labor teams, emphasizing that clear instructions and real-time updates are critical for efficient site operations. Additionally, safety concerns were a recurring theme, with many workers expressing a desire for more frequent safety briefings and improved access to protective gear.

Here is the observation Summary from Questionnaire and Workers Responses:

The questionnaire results from 50 construction workers provide valuable insights into the current working conditions on construction sites, including safety measures, raw material management, and workforce availability. Key observations from the responses include:

1. Working Hours:

- A significant portion of workers (75%) reported working 6-7 days per week, indicating long work hours and potentially high workloads. Only a small percentage work less than 4 days a week (15%).

2. Safety Measures:

- While 45% of workers are "Somewhat Satisfied" with the safety measures, 40% feel that improvements are necessary, with 10% considering the conditions "Hazardous." This suggests safety is a concern for many workers, though not all find it inadequate.

3. Raw Material Supply and Quality:

- The majority (60%) reported that raw materials are often in "Less than Requirement" quantities, indicating potential delays or inefficiencies in material supply.
- In terms of quality, over half (55%) described the materials as "Standard Quality," while 25% rated them as "Poor" and 10% as "Hazardous." This raises concerns about the materials being used on site, which may affect the overall construction quality.

4. Availability of Workers:

- Most workers (70%) find the availability of workers "Adequate," indicating that workforce levels are generally satisfactory. However, 20% reported workforce shortages, which could affect project timelines.

5. Safety Checks and Drills:

- Safety checks are typically performed on a "Weekly" basis (60%), but only 20% experience "Daily" or "Frequent" checks. Given that 20% report "Rare" safety checks, there is a need to increase the frequency of safety inspections.

6. Project Types:

- Half of the workers are involved in "Commercial" projects, with a smaller proportion working on "Government" (20%), "Private" (20%), and "Personal" (10%) projects. This suggests that most workers are engaged in larger-scale commercial construction.

7. Wages and Bonuses:

- A significant number (50%) are only "Somewhat Satisfied" with their wages and bonuses, while 30% feel that improvements are necessary. This suggests wage dissatisfaction is common and may need to be addressed.

8. Inspection and Safety Protocol Improvements:

- Workers recommended increasing the frequency of inspections, improving immediate hazard reporting, and enhancing training for safety protocols. These suggestions align with the perception of inadequate safety measures.

Conclusion:

The responses indicate that while workers are managing heavy workloads and generally find the workforce availability adequate, there are concerns about raw material supply, safety practices, and compensation. The feedback highlights the need for better safety management, more frequent inspections, and improved raw material handling to enhance overall construction site efficiency and worker satisfaction.

Finally, **the interview with a site manager** provided valuable insights into the leadership perspective. The manager emphasized the constant pressure to maintain project timelines while balancing budget constraints and labor availability. Managing the workforce was identified as one of the most complex aspects of the job, especially in coordinating various subcontractors and ensuring that each team is aligned with the project's overall objectives. Furthermore, the need for real-time problem-solving and decision-making was underscored as a crucial skill in the dynamic and often unpredictable environment of a construction site.

Observation Summary from Interview with Construction Site Project Manager

The interview with the construction site project manager provided important insights into the management of large-scale construction projects, focusing on the processes, requirements, and strategies that contribute to project efficiency. Key observations include:

1. Raw Material Management:

- Raw material needs are thoroughly projected before the project starts, and the planning generally proves accurate due to the inclusion of all relevant factors. This preemptive approach helps avoid shortages or delays.
- However, there is no advanced construction site management database in place. Instead, the site relies on an informal system that, while effective, may lack the structure of a more formalized system for monitoring materials and progress.

2. Financial and Budget Management:

- The financial aspects of the project, including budget and spending, are handled professionally, with systems in place to prevent overspending. This suggests that financial control is a priority, helping maintain project cost-efficiency.

3. Workforce Management:

- A hierarchical management structure is in place at the site, with workers reporting to their immediate supervisors. This tiered structure helps streamline decision-making and ensures that issues are escalated appropriately. This structure likely contributes to improved coordination and communication on the site.

4. Site Inspections and Quality Assurance:

- Regular site inspections by both the project manager and the site manager are conducted to maintain quality control. This suggests a proactive approach to quality assurance, ensuring the project adheres to the necessary standards throughout its duration.
- While inspections are carried out, the absence of a formalized site management system could leave room for missed details or less optimal data tracking.

5. Timeline and Scheduling:

- The project schedule is updated regularly to ensure that the project stays on track with the initial timeline. This indicates that time management and adherence to the project timeline are closely monitored, preventing delays.

6. Coordination and Decision-Making:

- The project uses a system that facilitates coordination and decision-making. This system, while not necessarily formal, appears to help manage both human and material resources efficiently, reducing miscommunication and keeping the project on track.

Conclusion:

The interview revealed that although the project relies on some informal systems, there is a clear focus on pre-project planning, quality assurance, and financial management, which helps keep projects efficient. However, the lack of an advanced construction management database could present challenges as the project grows in complexity. The hierarchical management style, regular site inspections, and schedule updates further contribute to effective project coordination and timely completion.

These findings illustrate the interconnected challenges faced by both site managers and workers, highlighting the need for efficient management strategies and open lines of communication to ensure the successful completion of construction projects.

Fact Finding Chart

Objective	**Technique**	**Subject**(s)	**Time Commitment**
Getting the Overview of the Construction Industry and its domain	Background Reading	Research Papers, Journals	8-12 Hours
Understanding the Scope of The Construction Domain	Background Reading	Research Papers, Journals	6-8 Hours
Gathering Technical aspects of a single Construction Project	Site Visitation	Skyline Industries	3-4 Hours
Learning about the different roles of personnels involved in Construction	Interview	1 Site Manager, 2 Construction Workers	3 Hours
To Find Out the Difficulties faced by the Construction Personnels	Questionnaire	1 Contractor , 50 On-Site Workers	2 Hours

Requirement List

Combined requirements gathered from observations:

1. Raw Material Management:

- Ensure accurate projections and maintain adequate, high-quality material supply throughout the project.

2. Construction Site Management:

- Implement a formal database system for tracking materials, labor, timelines, and spending with real-time updates.

3. Safety Measures:

- Enhance safety protocols with more frequent inspections, drills, and an immediate hazard reporting system.

4. Labor Force:

- Maintain an adequate workforce and continue hierarchical management for effective coordination.

5. Scheduling:

- Regularly update the project schedule to adhere to timelines and prevent delays.

6. Financial Management:

- Ensure professional financial oversight and cost control to avoid overspending.

7. Quality Assurance:

- Conduct regular inspections and introduce a formal quality management system.

8. Project-Specific Planning:

- Tailor material and labor planning based on the project type (commercial, government, or private).

Key Areas for Improvement:

1. Increased Safety Frequency: More frequent and comprehensive safety inspections and drills.
2. Enhanced Inspection System: Develop a system that allows more regular and detailed inspections, with immediate feedback on potential issues.
3. Improved Raw Material Supply: Ensure that raw materials are always supplied in the required quantity and quality to meet the project needs.

This combined set of requirements highlights the need for a more structured management approach in several areas to improve project efficiency, safety, and quality control.

User Privileges

1. **Construction Manager**: Oversees the execution of construction projects, ensuring they meet deadlines, budgets, and quality standards.
2. **Construction Accountants**: Manages financial transactions, budget allocations, and audits related to construction projects.
3. **Finance Managers**: Controls financial planning and tracks costs to ensure project profitability and proper resource allocation.
4. **Logistics Managers**: Coordinates the transportation, storage, and supply of materials and equipment for construction sites.
5. **Inventory Managers**: Oversees material availability, procurement, and stock levels to prevent project delays.
6. **Project Analysts**: Provides data-driven insights to improve project efficiency, track performance, and minimize risks.
7. **Architects / Building Designers**: Designs functional, safe, and aesthetically pleasing buildings, integrating structural and material considerations.
8. **Quality Control Analysts / Testers**: Ensures that construction materials and processes meet safety and quality standards through regular inspections.
9. **Construction Workers**: Carries out hands-on construction tasks, implementing project plans under the supervision of site managers

User Class and Privileges Table

User Role	Entity Access	Privileges
Construction Manager	Projects, Accidents, Risk Management, Safety Management, Monitoring Tools	Full CRUD (Create, Read, Update, Delete) access to all project-related data, risk management, and safety
Construction Accountants	Budgets, Costs, Contracts, Finance Management	View and update budgets, financial reports, costs, and payment statuses
Finance Managers	Budgets, Costs, Contracts, Financial Reports	Full access to all financial data, including budget allocation, tracking overruns, and financial planning
Logistics Managers	Materials, Equipment, Suppliers, Transportation, Inventory Management	Update material supply, handle delivery schedules, monitor stock levels, and track equipment logistics
Inventory Managers	Materials, Equipment, Inventory Management	Monitor inventory, manage suppliers, and ensure availability of materials
Project Analysts	Projects, Costs, Risk Management, Quality Assurance	Analyze project performance, view costs, inspect quality standards, and report risks
Architects / Building Designers	Construction Designs, Monitoring Tools, Documentation, Standards	Access design data, update monitoring tools, review compliance with standards
Quality Control Analysts	Quality Assurance, Inspections, Materials, Standards	View and update inspection results, verify material compliance, and schedule follow-ups
Construction Workers	Safety Management, Accidents, Site Conditions	View safety protocols, report accidents, update worksite conditions, and track assigned tasks

Chapter 2: Database Design

Noun-Verb Analysis

All Noun-Verb Table

NOUNS	VERBS
Construction industry	building
civil engineer	assembling
infrastructure	contributes
Construction	ensures
project	growing
complexity	increasing
Long-Term Contracts	employs
Post-Construction Services	working
Challenges	involves
Opportunities	created
Market Size	introduces
largest	factored
Economic Impact	integration
National Economies	Tracking
workforce	managing
Design	designed
Delivery	ensuring
Contractors	prevent
Suppliers	checks
Stakeholders	enhance
Disciplines	organized
Technological Advancement	needed
Integration	meets
Construction Accountants	rise

Finance Managers	faces
Logistics Managers	employed
Inventory Managers	gather
Project Analysts	included
Architects / Building Designers	requires
Quality Control Analysts / Testers	provides
Building Information Modelling	shrinking
companies	estimating
timelines	setting
purpose	handling
database	remains
Monitoring Tool	planning
Measurements	overseeing
Materials	anticipate
Costs	mitigate
Budgets	emphasizes
Quality Assurance	requires
regular checks	present
construction standards	become
Communication	streamline
Coordination tools	finding
collaboration	reduce
participants	must (be factored)
Audience	minimizing
Measurements	ensures
complexity	offers
Management	can (be overlooked)
Concrete	can (get)

Steel	highlighting
Construction Designs	overseeing
Project	implementing
timelines	heightened
Workforce	anticipate
Standards	mitigate
Construction Industry	outlining
Demand	maintaining
Manual Labor	emphasizes
Construction Industry	identify
Challenges	outline
Developing Countries	leading
Process	finding
Comprehensive fact-finding Process	managed
Operations	means
Construction SIte	identifying
Approach	assessing
Multi-faceted Approach	faces
Insights	becomes
Challenges	ensuring
Intricacies	can
Background Research	Tracking
Questionnaire	meets
Interview	become
Key Personnel	finding
Complexities	providing
Construction Site	means

Human Resource Challenges	
Challenges	
Challenges	
Poor Productivity	
Inflation	
Costs	
Skilled Labor	
Competition	
Profit Margins	
Focus	
Costs	
Project Budgets	
Budgets	
Contingencies	
Practical Methods	
Budgets	
track	
Strategies	
pitfalls	
Budgets	
Project Costs	
Systems	
Robust Systems	
Construction	
Standards	
Balance	
Planning	
Coordination	

Execution	
Site Managers	
Project	
timelines	
Resource	
Resource Allocation	
Safety Regulations	
Communication	
Stakeholders	
Complexity	
Unforeseen Issues	
Equipment	
Malfunctions	
Supply Delays	
Weather Disruptions	
Factors	
Multi-faceted Nature	
Leadership	
Abilities	
Problem-Solving Abilities	
Discussions	
Project Teams	
Responsibilities	
Communication	
Stakeholders	
Importance	
Documentation	
Contracts	

Project Reports	
Safety Concerns	
Construction	
Fall Hazards	
Primary Causes	
Construction Sites	
Strategies	
Risks	
Factors	
Poor Site Conditions	
Site Conditions	
Safety Equipment	
Safety Protocols	
Protocols	
Construction Workers	
Heights	
Structures	
Unstable Structures	
Risk	
Safety Management	
Systems	
Regular Inspections	
Accidents	
Worker	
Worker well-being	
Risk Management	
Construction Projects	
Delays	

Overruns	
Inventory Management Systems	
Tasks	
Materials	
Procurement Process	
Transportation	
Materials	
Construction Sites	
Project	
Materials	
Construction Projects	
Unexpected Risks	
Structured Approach	
Knowledge Acquisition	
Team Selection	
Verification	

Truncated Noun-Verb Analysis Table

TRUNCATED NOUNS	TRUNCATED VERBS
Accidents	anticipate
Architects	assembling
Background Research	assessing
Budgets	building
Building Information Modelling	can (be overlooked)
Challenges	can (get)
Communication	contributes
Competition	created
Concrete	designed
Construction Accountants	ensuring
Construction Designs	employed
Construction Site	emphasize
Construction Sites	enhance
Construction Workers	estimate
Construction industry	faces
Contingencies	factor
Contractors	finding
Contracts	gathering
Coordination	growing
Coordination tools	handle
Costs	heighten
Delays	identify
Demand	implement
Design	increase
Developing Countries	integrate
Disciplines	introduce
Documentation	involve
Economic Impact	lead

Equipment	maintain
Execution	manage
Factors	means
Fall Hazards	meet
Finance Managers	mitigate
Heights	must (be factored)
Inflation	outline
Insights	oversee
Inventory Management Systems	plan
Inventory Managers	prevent
Key Personnel	provide
Knowledge Acquisition	reduce
Leadership	remain
Logistics Managers	rise
Long-Term Contracts	set
Management	shrink
Manual Labor	streamline
Market Size	tracking
Materials	work
Monitoring Tool	
Operations	
Opportunities	
Overruns	
Planning	
Poor Site Conditions	
Post-Construction Services	
Problem-Solving Abilities	
Procurement Process	
Profit Margins	
Project Analysts	

Project Costs	
Project Reports	
Quality Assurance	
Quality Control Analysts	
Questionnaire	
Regular Inspections	
Responsibilities	
Risk Management	
Risks	
Safety Concerns	
Safety Equipment	
Safety Management	
Safety Protocols	
Safety Regulations	
Site Managers	
Skilled Labor	
Stakeholders	
Standards	
Steel	
Suppliers	
Supply Delays	
Team Selection	
Technological Advancement	
Transportation	
Unforeseen Issues	
Unstable Structures	
Verification	
Weather Disruptions	
Worker well-being	
Workforce	

Candidate Entity, Attribute, Relationship Set Table

Candidate Entity Set	Candidate Attribute Set	Candidate Relationship Set
Accidents	Budgets	anticipate
Architects	Contingencies	assembling
Background Research	Costs	assessing
Building Information Modelling	Delays	building
Challenges	Demand	can (be overlooked)
Communication	Design	can (get)
Competition	Documentation	contributes
Concrete	Economic Impact	created
Construction Accountants	Equipment	designed
Construction Designs	Execution	ensuring
Construction Site	Factors	employed
Construction Sites	Fall Hazards	emphasize
Construction Workers	Heights	enhance
Construction Industry	Inflation	estimate
Contractors	Insights	faces
Contracts	Knowledge Acquisition	factor
Coordination	Leadership	finding
Coordination Tools	Long-Term Contracts	gathering
Costs	Management	growing
Developing Countries	Manual Labor	handle
Disciplines	Market Size	heighten
Documentation	Materials	identify
Equipment	Monitoring Tool	implement
Finance Managers	Operations	increase
Inventory Management Systems	Opportunities	integrate
Inventory Managers	Overruns	introduce

Key Personnel	Planning	involve
Logistics Managers	Poor Site Conditions	lead
Project Analysts	Procurement Process	maintain
Project Costs	Profit Margins	manage
Project Reports	Project Costs	means
Quality Assurance	Quality Assurance	meet
Quality Control Analysts	Questionnaire	mitigate
Risk	Regular Inspections	must (be factored)
Risk Management	Responsibilities	outline
Safety Concerns	Risk	oversee
Safety Equipment	Safety Management	plan
Safety Protocols	Safety Protocols	prevent
Safety Regulations	Safety Regulations	provide
Site Managers	Site Conditions	reduce
Skilled Labor	Standards	remain
Stakeholders	Structured Approach	rise
Steel	Supply Delays	set
Suppliers	Systems	shrink
Team Selection	Team Selection	streamline
Technological Advancement	Transportation	tracking
Unstable Structures	Unforeseen Issues	work
Verification	Weather Disruptions	
Worker well-being	Worker well-being	
Workforce	Workforce	

Rejected Noun Reason Table

Noun	Reject Reason
Abilities	Attribute (better associated with roles or skills)
Approach	Vague (unclear as an entity)
Architects / Building Designers	Duplicate (covered by "Architects")
Audience	Irrelevant (outside the system's focus)
Balance	Vague (too abstract)
Complexities	Duplicate
Complexity	Attribute (better as an attribute for tasks/projects)
Comprehensive fact-finding Process	Association (a process, not an entity)
Construction	General (too broad as a noun)
Construction Industry	Duplicate (already covered in truncated list)
Construction Projects	Duplicate (already covered by "Project" or "Projects")
Delivery	General (too vague for specific tracking)
Discussions	Association (represents communication between entities)
Focus	Vague (unclear application as an entity)
Human Resource Challenges	Attribute (better as an issue or challenge)
Importance	Vague (too abstract as an entity)
Integration	Association (represents relationships between systems)
Interview	Association (related to human interaction)
Intricacies	Attribute (can be better described as part of processes)
Malfunctions	Attribute (related to equipment)
Measurements	Attribute (better suited to specific attributes)
Multi-faceted Approach	Vague (unclear as an entity)
Multi-faceted Nature	Vague (unclear as an entity)

National Economies	Irrelevant (not part of the construction site scope)
Poor Productivity	Attribute (related to workforce performance)
Practical Methods	Attribute (better described as part of strategies)
Primary Causes	Attribute (associated with incidents or safety)
Process	General (too vague)
Project	Duplicate (already covered in truncated list)
Project Budgets	Duplicate (already covered by "Budgets")
Project Teams	Duplicate (covered under "Teams" or "Stakeholders")
Protocols	Duplicate (already covered by "Safety Protocols")
Quality Control Analysts / Testers	Duplicate (covered by "Quality Control Analysts")
Resource	Attribute (better as "Resource Allocation")
Resource Allocation	Attribute (describes resource management)
Robust Systems	Attribute (part of system attributes)
Site Conditions	Attribute (related to site attributes or risks)
Strategies	Association (represents planning and actions)
Structures	General (too broad in construction context)
Tasks	General (too vague as an entity)
Unexpected Risks	Duplicate (already covered by "Risks")
Worker	Irrelevant (too general, better as "Construction Workers")
civil engineer	Irrelevant (specific to a job role)
collaboration	Association (describes teamwork and coordination)
companies	General (too broad, can be part of stakeholders)
complexity	Attribute (better as an attribute for projects)
construction standards	Duplicate (already covered by "Standards")
database	General (too broad for a specific entity)
infrastructure	General (too broad)
largest	Vague (unclear as a meaningful entity)
participants	Irrelevant (better categorized as stakeholders)
pitfalls	Attribute (related to risks or challenges)

project	Duplicate (already covered in truncated list)
purpose	Vague (unclear representation)
regular checks	Association (represents actions for quality control)
timelines	Duplicate (already covered by "timelines")
track	Vague (unclear as an entity)
workforce	Duplicate (already covered in truncated list)

Finalized Candidate Entity, Attribute, Relationship Set Table

Entity (Finalized)	Attribute Set (Finalized)	Relationship Set (Finalized)
Projects Table	ProjectID (PK), ProjectName, StartDate, EndDate, ClientName, Location, Status (Ongoing, Completed, etc.)	Leads coordination, Oversee costs, Manage quality assurance
Materials Table	MaterialID (PK), MaterialName, ProjectID (FK), Quantity, Unit, AvailabilityStatus	Linked to Projects, Used in quality checks
Monitoring Tools Table	ToolID (PK), ToolName, MeasurementType, ProjectID (FK), MeasurementValue, Unit	Track project measurements
Costs & Budgets Table	CostID (PK), ProjectID (FK), BudgetedCost, ActualCost, Category, Date	Estimate and track project costs
Quality Assurance Table	CheckID (PK), ProjectID (FK), MaterialID (FK), DateOfCheck, ComplianceStatus, InspectorName	Perform quality checks
Participants Table	ParticipantID (PK), Name, Role, ProjectID (FK), ContactInfo	Participate in and manage projects
Communication Table	CommunicationID (PK), ProjectID (FK), Date, ParticipantID (FK), Message, Status (Open, Resolved)	Manage coordination, Track communication activities

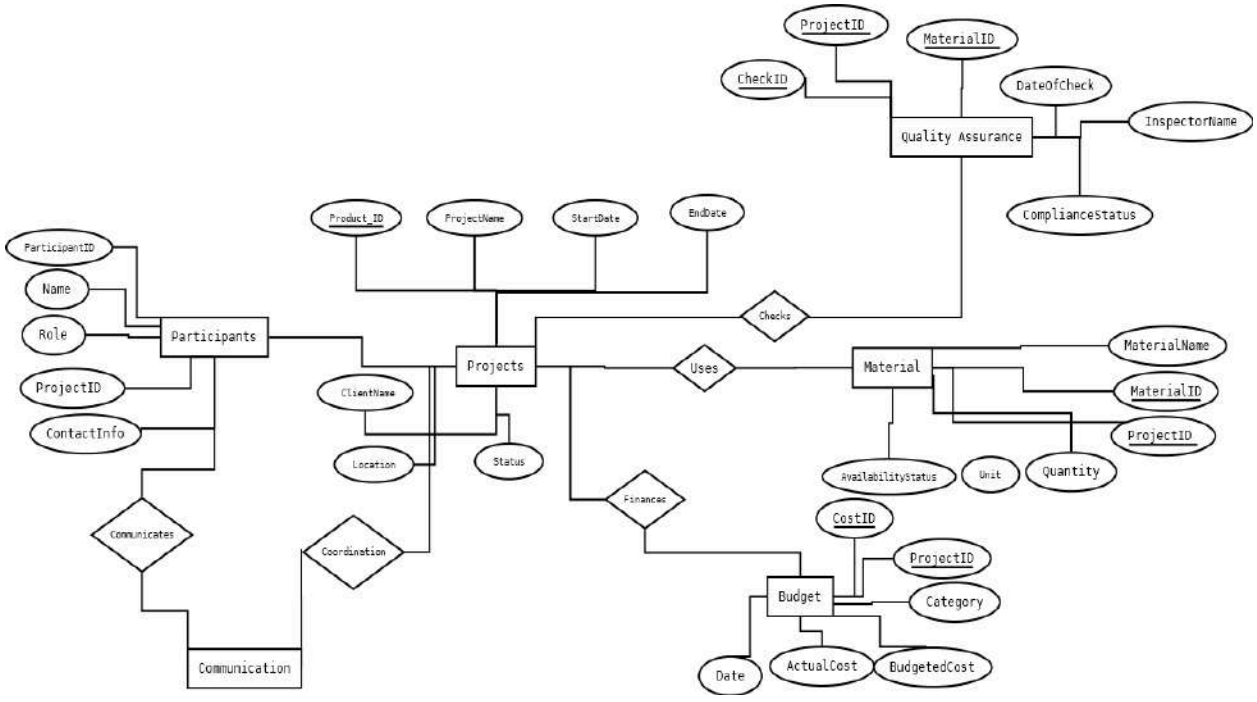
Entity (Finalized)	Attribute Set (Finalized)	Relationship Set (Finalized)
Standards Table	StandardID (PK), StandardDescription, Category, ApplicableTo	Provide guidelines for construction and safety protocols
Inspections Table	InspectionID (PK), ProjectID (FK), Date, InspectorName, Result (Pass, Fail), Comments	Perform regular inspections

Schema and ERD Design

The schema is built using the ER Diagram, and relationships are constructed with foreign key constraints to depict various cardinalities, including one-to-one and one-to-many. Hence, all key associations between entities - for example, projects, materials, participants, and inspections - are accurately captured. The Initial Relations are :

1. **Projects**
2. **Materials**
3. **Monitoring Tools**
4. **Costs & Budgets**
5. **Quality Assurance**
6. **Participants**
7. **Communication**
8. **Standards**
9. **Inspections**

ER Dlagram - Version 1:



ER Diagram Improvement

Identify Entity Types

- **Projects**
  - Attributes: `ProjectID` (PK), `ProjectName`, `StartDate`, `EndDate`, `ClientName`, `Location`, `Status`
- **Materials**
  - Attributes: `MaterialID` (PK), `MaterialName`, `ProjectID` (FK), `Quantity`, `Unit`, `AvailabilityStatus`
- **Monitoring Tools**
  - Attributes: `ToolID` (PK), `ToolName`, `MeasurementType`, `ProjectID` (FK), `MeasurementValue`, `Unit`
- **Costs & Budgets**
  - Attributes: `CostID` (PK), `ProjectID` (FK), `BudgetedCost`, `ActualCost`, `Category`, `Date`
- **Quality Assurance**
  - Attributes: `CheckID` (PK), `ProjectID` (FK), `MaterialID` (FK), `DateOfCheck`, `ComplianceStatus`, `InspectorName`
- **Participants**
  - Attributes: `ParticipantID` (PK), `Name`, `Role`, `ProjectID` (FK), `ContactInfo`
- **Communication**
  - Attributes: `CommunicationID` (PK), `ProjectID` (FK), `ParticipantID` (FK), `Date`, `Message`, `Status`
- **Standards**
  - Attributes: `StandardID` (PK), `StandardDescription`, `Category`, `ApplicableTo`
- **Inspections**
  - Attributes: `InspectionID` (PK), `ProjectID` (FK), `Date`, `InspectorName`, `Result`, `Comments`

Identify Relationship Types

Below are the primary relationships among the entities, noting cardinality and participation requirements where relevant.

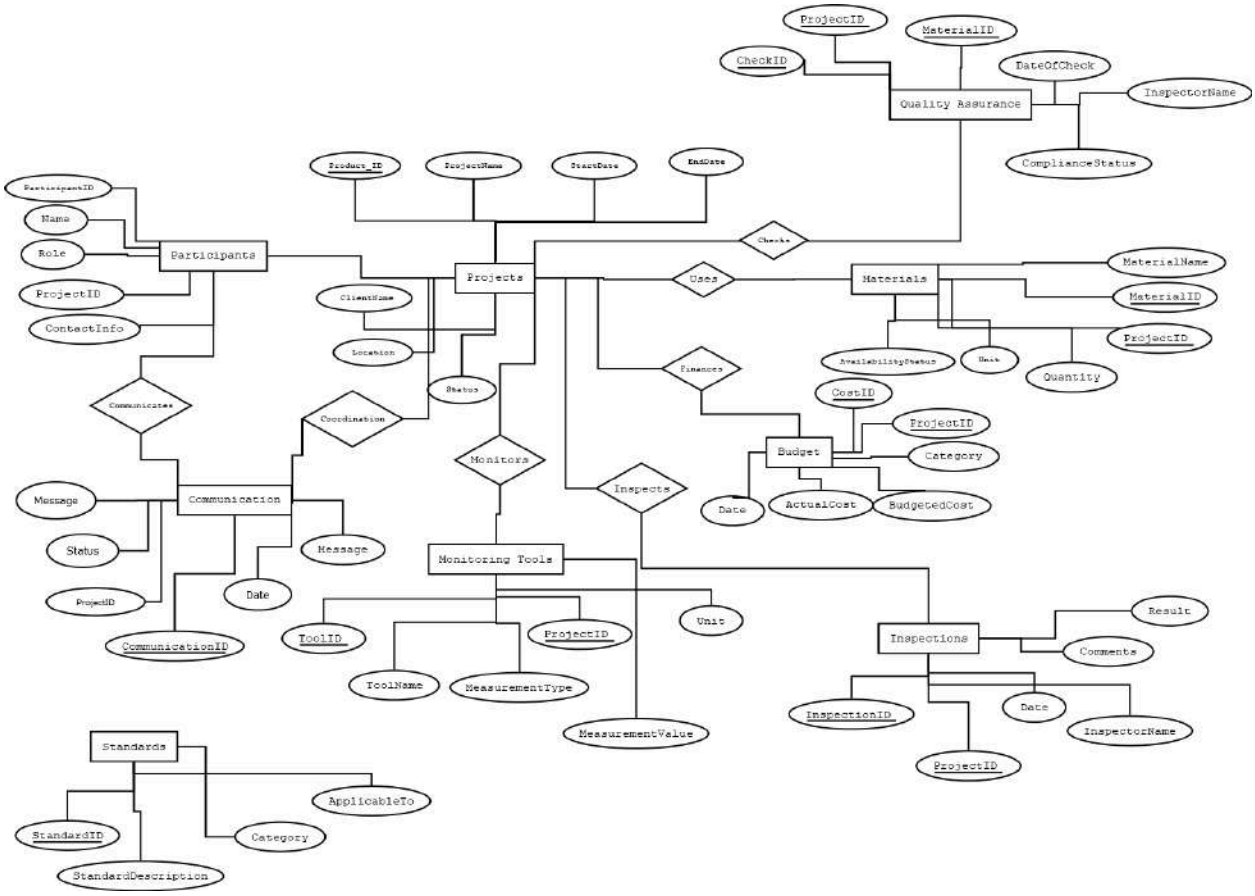
- **Project-Materials Relationship**
  - **Description**: Each project can use multiple materials, but each material is dedicated to one project.
  - **Cardinality**: One-to-Many (1) from `Projects` to `Materials`
  - **Participation**: Mandatory for both `Projects` and `Materials` since materials are essential resources for construction.
- **Project-Monitoring Tools Relationship**
  - **Description**: Multiple monitoring tools are employed in a project, with each tool specific to one project.
  - **Cardinality**: One-to-Many (1) from `Projects` to `Monitoring Tools`
  - **Participation**: Mandatory for both entities to track the tools necessary for monitoring measurements.
- **Project-Costs & Budgets Relationship**
  - **Description**: A project has various costs and budgets to manage different expense categories.
  - **Cardinality**: One-to-Many (1) from `Projects` to `Costs & Budgets`
  - **Participation**: Mandatory for both to monitor the financial aspects of each project accurately.
- **Project-Quality Assurance Relationship**
  - **Description**: Each project requires multiple quality checks, focusing on compliance with standards.
  - **Cardinality**: One-to-Many (1) from `Projects` to `Quality Assurance`
  - **Participation**: Mandatory for both to ensure that projects meet quality standards.
- **Project-Participants Relationship**
  - **Description**: A project involves many participants, each with a distinct role.
  - **Cardinality**: One-to-Many (1) from `Projects` to `Participants`
  - **Participation**: Mandatory for both as participants are vital for project operations.

- **Project-Communication Relationship**
  - **Description**: Communications occur within each project among participants.
  - **Cardinality**: One-to-Many (1) from `Projects` to `Communication`
  - **Participation**: Mandatory, as logging communications is essential for project coordination.
- **Project-Standards Relationship**
  - **Description**: Projects adhere to standards which outline the guidelines and requirements they must follow.
  - **Cardinality**: Many-to-Many (M), since multiple projects can adopt various standards, and each standard may apply to different projects.
  - **Participation**: Mandatory for both to ensure compliance across all projects.
- **Project-Inspections Relationship**
  - **Description**: Each project undergoes regular inspections to confirm adherence to safety, quality, and other criteria.
  - **Cardinality**: One-to-Many (1) from `Projects` to `Inspections`
  - **Participation**: Mandatory, as inspections are integral to maintaining standards.

ER Diagram Analysis

Although the current schema may succeed in modeling core relationships, further fine-tuning can actually enhance clarity and reduce redundancy and thus optimize structure in favor of better querying efficiency and adherence to higher orders of normalization in a database.

ER DIagram - Final Version :



Mapping ER Model to Relational Model

Entity to Relation Tables:

1. Projects

Schema:

```
"Projects": [
        "ProjectID (Primary Key)",
        "ProjectName",
            "StartDate",
        "EndDate",
        "ClientName",
       "Location",
       "Status",
],
```

Attributes	**Constraints**	**Data Type**
Project Id	Primary key	INT
Project Name	Not Null	VARCHAR
Startdate	Not Null	DATE
End Date	Not Null	DATE
Client Name	Not Null	VARCHAR
Location	Not Null	VARCHAR
Status	Not Null	VARCHAR

2. Materials

Schema:

```
"Materials": [
        "MaterialID (Primary Key)",
        "MaterialName",
        "ProjectID (Foreign Key to Projects)",
        "Quantity",
        "Unit",
        "AvailabilityStatus",
    ],
```

Attributes	**Constraints**	**Data Type**
MaterialID	Primary Key	INT
MaterialName	NOT NULL	VARCHAR
ProjectID	Foreign Key (Reference: Project)	INT
Quantity	NOT NULL	INT
Unit	NOT NULL	VARCHAR
AvailabilityStatus	NOT NULL	VARCHAR

3. Monitoring Tools

Schema:

```
"Monitoring Tools": [
        "ToolID (Primary Key)",
        "ToolName",
        "MeasurementType",
        "ProjectID (Foreign Key to Projects)",
        "MeasurementValue",
        "Unit",
    ],
```

Attributes	**Constraints**	**Data Type**
ToolID	Primary Key	INT
ToolName	NOT NULL	VARCHAR
ProjectID	Foreign Key (Reference: Project)	INT
MeasurementType	NOT NULL	VARCHAR
MeasurementValue	NOT NULL	FLOAT
Unit	NOT NULL	VARCHAR

4. Costs and Budget

Schema

"Costs & Budgets": [
"CostID (Primary Key)",
"ProjectID (Foreign Key to Projects)",
"BudgetedCost",
"ActualCost",
"Category",
"Date",
],

Attributes	**Constraints**	**Data Type**
CostID	Primary Key	INT
BudgetedCost	NOT NULL	FLOAT
ProjectID	Foreign Key (Reference: Project)	INT
ActualCost	NOT NULL	FLOAT
Category	NOT NULL	VARCHAR
Date	NOT NULL	DATE

5. Quality Assurance

Schema:

"Quality Assurance": [
"CheckID (Primary Key)",
"ProjectID (Foreign Key to Projects)",
"MaterialID (Foreign Key to Materials)",
"DateOfCheck",
"ComplianceStatus",
"InspectorName",
],

Attributes	**Constraints**	**Data Type**
CheckID	Primary Key	INT
MaterialID	Foreign Key (Reference: Materials)	INT
ProjectID	Foreign Key (Reference: Project)	INT
InspectorName	Foreign Key (Reference: Inspections)	VARCHAR
ComplianceStatus	NOT NULL	VARCHAR
DateOfCheck	NOT NULL	DATE

6. Participants

Schema:

"Participants": [
"ParticipantID (Primary Key)",
"Name",
"Role",
"ProjectID (Foreign Key to Projects)",
"ContactInfo",
“DateOfCheck”
],

Attributes	**Constraints**	**Data Type**
ParticipantID	Primary Key	INT
Name	NOT NULL	VARCHAR
ProjectID	Foreign Key (Reference: Project)	INT
Role	NOT NULL	VARCHAR
ContactInfo	NOT NULL	VARCHAR
DateOfCheck	NOT NULL	DATE

7. Communication & coordination

Schema:

"Communication & Coordination": [
"CommunicationID (Primary Key)",
"ProjectID (Foreign Key to Projects)",
"Date",
"ParticipantID (Foreign Key to Participants)",
"Message",
"Status",
],

Attributes	**Constraints**	**Data Type**
CommunicationID	Primary Key	INT
ParticipantID	Foreign Key (Reference: Participants)	INT
ProjectID	Foreign Key (Reference: Project)	INT
Message	NOT NULL	VARCHAR
Status	NOT NULL	VARCHAR
Date	NOT NULL	DATE

8. Standards

Schema:

```
"Standards": [
        "StandardID (Primary Key)",
        "StandardDescription",
        "Category",
        "ApplicableTo",
    ],
```

Attributes	**Constraints**	**Data Type**
StandardID	Primary Key	INT
StandardDescription	NOT NULL	TEXT
Category	NOT NULL	VARCHAR
ApplicableTo	NOT NULL	VARCHAR

9. Inspections

Schema:

```
"Inspections": [
        "InspectionID (Primary Key)",
        "ProjectID (Foreign Key to Projects)",
        "Date",
        "InspectorName",
        "Result",
        "Comments",
    ],
}
```

Attributes	**Constraints**	**Data Type**
InspectionID	Primary Key	INT
Result	NOT NULL	VARCHAR
ProjectID	Foreign Key (Reference: Project)	INT
InspectorName	NOT NULL	VARCHAR
Comments	NOT NULL	TEXT
Date	NOT NULL	DATE

Entities and their attributes (with primary key and foreign key, if any)

Projects (*ProjectID*, ProjectName, StartDate, EndDate, ClientName, Location, Status)

Materials (*MaterialID*, MaterialName, ProjectID (FK), Quantity, Unit, AvailabilityStatus)

Monitoring Tools (*ToolID*, ToolName, MeasurementType, ProjectID (FK), MeasurementValue, Unit)

Costs & Budgets (*CostID*, ProjectID (FK), BudgetedCost, ActualCost, Category, Date)

Quality Assurance (*CheckID*, ProjectID (FK), MaterialID (FK), DateOfCheck, ComplianceStatus, InspectorName)

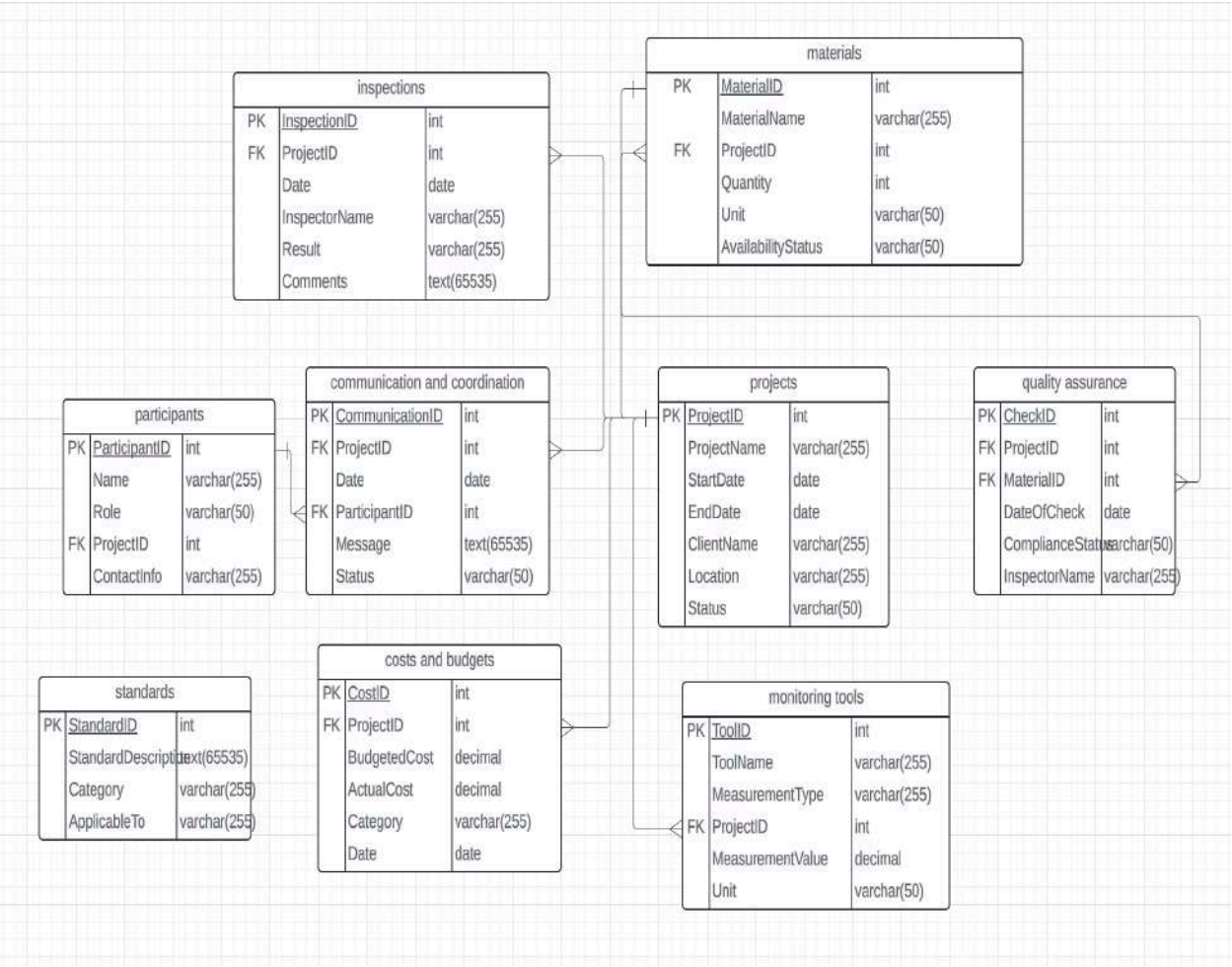
Participants (*ParticipantID*, Name, Role, ProjectID (FK), ContactInfo)

Communication (*CommunicationID*, ProjectID (FK), ParticipantID (FK), Date, Message, Status)

Standards (*StandardID*, StandardDescription, Category, ApplicableTo)

Inspections (*InspectionID*, ProjectID (FK), Date, InspectorName, Result, Comments)

Schema Diagram



Create DDL Scripts

```
CREATE TABLE Projects (
    ProjectID SERIAL PRIMARY KEY,
    ProjectName VARCHAR(255),
    StartDate DATE,
    EndDate DATE,
    ClientName VARCHAR(255),
    Location VARCHAR(255),
    Status VARCHAR(50)
);

CREATE TABLE Materials (
    MaterialID SERIAL PRIMARY KEY,
    MaterialName VARCHAR(255),
    ProjectID INT REFERENCES Projects(ProjectID),
    Quantity INT,
    Unit VARCHAR(50),
    AvailabilityStatus VARCHAR(50)
);

CREATE TABLE MonitoringTools (
    ToolID SERIAL PRIMARY KEY,
    ToolName VARCHAR(255),
    MeasurementType VARCHAR(255),
    ProjectID INT REFERENCES Projects(ProjectID),
    MeasurementValue DECIMAL(10, 2),
    Unit VARCHAR(50)
);
```

```
CREATE TABLE CostsAndBudgets (
    CostID SERIAL PRIMARY KEY,
    ProjectID INT REFERENCES Projects(ProjectID),
    BudgetedCost DECIMAL(10, 2),
    ActualCost DECIMAL(10, 2),
    Category VARCHAR(255),
    Date DATE
);

CREATE TABLE QualityAssurance (
    CheckID SERIAL PRIMARY KEY,
    ProjectID INT REFERENCES Projects(ProjectID),
    MaterialID INT REFERENCES Materials(MaterialID),
    DateOfCheck DATE,
    ComplianceStatus VARCHAR(50),
    InspectorName VARCHAR(255)
);

CREATE TABLE Participants (
    ParticipantID SERIAL PRIMARY KEY,
    Name VARCHAR(255),
    Role VARCHAR(50),
    ProjectID INT REFERENCES Projects(ProjectID),
    ContactInfo VARCHAR(255)
);

CREATE TABLE CommunicationAndCoordination (
    CommunicationID SERIAL PRIMARY KEY,
    ProjectID INT REFERENCES Projects(ProjectID),
    Date DATE,
    ParticipantID INT REFERENCES Participants(ParticipantID),
    Message TEXT,
    Status VARCHAR(50)
);
```

```
CREATE TABLE Standards (
    StandardID SERIAL PRIMARY KEY,
    StandardDescription TEXT,
    Category VARCHAR(255),
    ApplicableTo VARCHAR(255)
);

CREATE TABLE Inspections (
    InspectionID SERIAL PRIMARY KEY,
    ProjectID INT REFERENCES Projects(ProjectID),
    Date DATE,
    InspectorName VARCHAR(255),
    Result VARCHAR(255),
    Comments TEXT
);
```

Chapter 3: Normalization of Database

Normalization and Schema Refinement

Original Design of Database :

- **Projects**
  - Attributes: `ProjectID` (PK), `ProjectName`, `StartDate`, `EndDate`, `ClientName`, `Location`, `Status`
- **Materials**
  - Attributes: `MaterialID` (PK), `MaterialName`, `ProjectID` (FK), `Quantity`, `Unit`, `AvailabilityStatus`
- **Monitoring Tools**
  - Attributes: `ToolID` (PK), `ToolName`, `MeasurementType`, `ProjectID` (FK), `MeasurementValue`, `Unit`
- **Costs & Budgets**
  - Attributes: `CostID` (PK), `ProjectID` (FK), `BudgetedCost`, `ActualCost`, `Category`, `Date`
- **Quality Assurance**
  - Attributes: `CheckID` (PK), `ProjectID` (FK), `MaterialID` (FK), `DateOfCheck`, `ComplianceStatus`, `InspectorName`
- **Participants**
  - Attributes: `ParticipantID` (PK), `Name`, `Role`, `ProjectID` (FK), `ContactInfo`
- **Communication**
  - Attributes: `CommunicationID` (PK), `ProjectID` (FK), `ParticipantID` (FK), `Date`, `Message`, `Status`
- **Standards**
  - Attributes: `StandardID` (PK), `StandardDescription`, `Category`, `ApplicableTo`
- **Inspections**
  - Attributes: `InspectionID` (PK), `ProjectID` (FK), `Date`, `InspectorName`, `Result`, `Comments`

Dependency Analysis

All types of dependencies (PK, FK, Functional Dependencies) for each relation :

1. **Projects Table**
   Projects (ProjectID, ProjectName, StartDate, EndDate, ClientName, Location, Status)
   - **Primary Key**: ProjectID
   - **Foreign Key:** None
   - **Functional dependencies:**

   ProjectID-> ProjectName, StartDate, EndDate, ClientName, Location, Status

2. **Materials Table**
   Materials (MaterialID, MaterialName, ProjectID (FK), Quantity, Unit, AvailabilityStatus)
   - **Primary Key:** MaterialID
   - **Foreign Key:** ProjectID
   - **Functional dependencies:**

   MaterialID -> MaterialName, ProjectID , Quantity, Unit, AvailabilityStatus

3. **Monitoring Tools Table**
   MonitoringTools (ToolID, ToolName, MeasurementType, ProjectID (FK), MeasurementValue, Unit)
   - **Primary Key:** ToolID
   - **Foreign Key:** ProjectID
   - **Functional dependencies:**

   ToolID-> ToolName, MeasurementType, *ProjectID*,MeasurementValue, Unit

4. **Costs & Budgets Table**
   Costs & Budgets (CostID, ProjectID (FK), BudgetedCost, ActualCost, Category, Date)
   - **Primary Key:** CostID
   - **Foreign Key:** ProjectID
   - **Functional dependencies:**

   CostID-> ProjectID, BudgetedCost, ActualCost, Category, Date

5. **Quality Assurance Table**
   Quality Assurance (CheckID, ProjectID (FK), MaterialID (FK), DateOfCheck, ComplianceStatus, InspectorName)
   - **Primary Key:** CheckID
   - **Foreign Key:** ProjectID, MaterialID
   - **Functional dependencies:**

   CheckID-> ProjectID (FK), MaterialID (FK), DateOfCheck, ComplianceStatus, InspectorName

6. **Participants Table**
   Participants (ParticipantID, Name, Role, ProjectID (FK), ContactInfo)
   - **Primary Key:** ParticipantID
   - **Foreign Key:** ProjectID
   - **Functional dependencies:**

   ParticipantID-> ParticipantID, Name, Role, ProjectID (FK), ContactInfo

7. **Communication Table**
   Communication (CommunicationID, ProjectID (FK), ParticipantID (FK), Date, Message, Status)
   - **Primary Key:** CommunicationID
   - **Foreign Key:** ProjectID
   - **Functional dependencies:**

   CommunicationID-> ProjectID, ParticipantID, Date, Message, Status

8. **Standards Table**
   Standards (*StandardID*, StandardDescription, Category, ApplicableTo)
   - **Primary Key:** StandardID
   - **Foreign Key:** None
   - **Functional dependencies:**

   StandardID-> *StandardID*, StandardDescription, Category, ApplicableTo

9. **Inspections Table**
   Inspections (InspectionID, ProjectID (FK), Date, InspectorName, Result, Comments)
   - **Primary Key**: InspectionID
   - **Foreign Key:** ProjectID,
   - **Functional dependencies:**

   InspectionID -> ProjectID (FK), Date, InspectorName, Result, Comments

Redundancies and Anomalies Documentation

Redundancies

1. **Projects Table:**

Attributes: ProjectID, ProjectName, StartDate, EndDate, ClientName, Location, Status

Redundancy:

- Storing ClientName directly can lead to duplication if multiple projects share the same client.
- Storing Location directly may cause redundancy if multiple projects are located in the same area.

Solution:

- Create a separate `Clients` table to store `ClientID` and `ClientName`.
- Create a separate `Locations` table to store `LocationID` and `Location`, and replace `Location` in `Projects` with `LocationID` (FK).

2. **Materials Table:**

Attributes: `MaterialID`, `MaterialName`, `ProjectID (FK)`, `Quantity`, `Unit`, `AvailabilityStatus`

Redundancy:

- The `ProjectID` here indicates a relationship that can lead to redundancy if the same material is used across multiple projects.

Solution:

- Consider keeping `MaterialID` and `MaterialName` in a separate `Materials` table, linking it to a many-to-many relationship with projects via a junction table (e.g., `Material_Project`), which can hold `Quantity`, `Unit`, and `AvailabilityStatus`.

3. **Monitoring Tools Table:**

Attributes: `ToolID`, `ToolName`, `MeasurementType`, `ProjectID (FK)`, `MeasurementValue`, `Unit`

Redundancy:

- Including `ProjectID` here may lead to redundancy if the same tool is used in multiple projects.

Solution:

- Like materials, consider a many-to-many relationship by creating a junction table (e.g., `Tool_Project`), which can hold `MeasurementValue` and `Unit`.

4. **Costs & Budgets Table:**

Attributes: `CostID`, `ProjectID (FK)`, `BudgetedCost`, `ActualCost`, `Category`, `Date`

Redundancy:

- Storing `Category` directly can lead to inconsistency if not standardized across the database.

Solution:

- Create a separate `Categories` table with `CategoryID` and `CategoryName`, and replace `Category` in this table with `CategoryID` (FK).

5. **Quality Assurance Table:**

Attributes: `CheckID`, `ProjectID (FK)`, `MaterialID (FK)`, `DateOfCheck`, `ComplianceStatus`, `InspectorName`

Redundancy:

- Including `ProjectID` here may lead to redundancy if the same tool is used in multiple projects.

Solution:

- Storing `InspectorName` directly can cause duplication if the same inspector is involved in multiple checks.

6. **Participants Table:**

Attributes: `ParticipantID`, `Name`, `Role`, `ProjectID (FK)`, `ContactInfo`

Redundancy:

- Storing `Role` directly can lead to inconsistencies if not defined in a standardized way.

Solution:

- Create a `Roles` table with `RoleID` and `RoleName`, and replace `Role` in this table with `RoleID` (FK).

7. **Communication Table:**

Attributes: CommunicationID, ProjectID (FK), ParticipantID (FK), Date, Message, Status

Redundancy:

- The Status attribute may vary for messages and could lead to inconsistency if not standardized.

Solution:

- Create a Status table for communication statuses and replace Status with StatusID (FK).

8. **Inspections Table:**

Attributes: InspectionID, ProjectID (FK), Date, InspectorName, Result, Comments

Redundancy:

- Similar to Quality Assurance, storing InspectorName directly can lead to duplication.

Solution:

- Use InspectorID from the Inspectors table instead of InspectorName.

Anomalies

1. Material Table Anomalies:
    - Insert Anomalies:

New Material can't be added unless a Project is assigned to it.
It's possible to have extra material or reusable material from another project which isn't assigned to any project.

2. Cost & Budget Table Anomalies :
    - Insert Anomalies:

A New Budget or Cost can't be inserted unless a Project has been assigned to it.

3. Quality Assurance Table Anomalies :
    - Insert Anomalies:

A Quality Assurance check of a material cannot be inserted unless the availability status of the material is 'in-stock'.

4. Participants Table Anomalies:
    - Deletion Anomalies:

Deletion of a Participant may result in data loss to tables such as 'Project' or 'Inspection' as the Participant might be an entity in the above-mentioned tables and has a ForeignKey Constraint to the same.

5. Inspections Table Anomalies:
    - Insert Anomalies:

The attribute 'Inspector Name' should be a reference key to the Participants table, in order to increase the ease of access of the information and for the updation of the same.

6. Standards Table Anomalies:
    - Updation Anomalies:

The Standards table has been deemed redundant as the functionality is achieved through 'Inspections' Table. Hence, Duplicate Records will be formed. Updations in the Inspection Table won't be reflected in the Standards table. Hence , Multiple updates will be needed to maintain the Standards table.
Action : Removal of Standards table from the Schema.

7. Reference to client details/information anomaly

When referencing the client table from projects table, there is only client name as an attribute and no further details, what we can do instead is add clientID referencing to participants tables.

Normalization Process

First Normal Form (1NF):

All tables in the revised schema already adhere to 1NF. Each attribute contains atomic values, and primary keys are defined.

Second Normal Form (2NF):

To check if a schema is in second normal form or not we check for partial dependencies. In this schema, none of the tables contain composite primary keys, which means we can proceed without changes.

- **Material_Project** has a composite primary key (MaterialID, ProjectID), and each non-key attribute (Quantity, Unit, AvailabilityStatus) depends on both keys.
- **Tool_Project** has a composite primary key (ToolID, ProjectID), and each non-key attribute (MeasurementValue, Unit) depends on both keys.
- Other tables have single primary keys, and all non-key attributes depend solely on those keys.

Third Normal Form (3NF):

Here we eliminate all the transitive dependencies.

1. **Projects**:
    i. No transitive dependencies are present.
2. **Costs & Budgets**:
    i. Ensure `CategoryID` refers to `Categories` and is not dependent on any other non-key attribute.
3. **Participants**:
    i. `RoleID` refers to `Roles`, ensuring it does not depend on other non-key attributes.
4. **Quality Assurance**:
    i. `InspectorID` refers to `Inspectors`, ensuring it does not depend on other non-key attributes.
5. **Communication**:
    i. `StatusID` refers to `Status`, ensuring it does not depend on other non-key attributes.
6. **Standards**:
    i. Ensure `CategoryID` is linked to `Categories` and does not depend on non-key attributes.

Summary of the Normalized Schema

After checking for 1NF, 2NF, and 3NF, we confirm that the schema is normalized.The schema is now normalized up to the third normal form (3NF). And because all functional dependencies have their determinant as a superkey, it is also in Boyce-Codd Normal Form (BCNF). Hence, the final schema:

1. **Projects**:
    - **Attributes**: ProjectID (PK), ProjectName, StartDate, EndDate, ClientID (FK), LocationID (FK), Status
2. **Clients**:
    - **Attributes**: ClientID (PK), ClientName, ContactInfo
3. **Locations**:
    - **Attributes**: LocationID (PK), LocationName
4. **Materials**:
    - **Attributes**: MaterialID (PK), MaterialName
5. **Material_Project**:
    - **Attributes**: MaterialID (FK), ProjectID (FK), Quantity, Unit, AvailabilityStatus
6. **Monitoring Tools**:
    - **Attributes**: ToolID (PK), ToolName, MeasurementType
7. **Tool_Project**:
    - **Attributes**: ToolID (FK), ProjectID (FK), MeasurementValue, Unit
8. **Costs & Budgets**:
    - **Attributes**: CostID (PK), ProjectID (FK), BudgetedCost, ActualCost, CategoryID (FK), Date
9. **Categories**:
    - **Attributes**: CategoryID (PK), CategoryName
10. **Quality Assurance**:
    - **Attributes**: CheckID (PK), ProjectID (FK), MaterialID (FK), DateOfCheck, ComplianceStatus, InspectorID (FK)
11. **Inspectors**:
    - **Attributes**: InspectorID (PK), InspectorName

12. **Participants**:
    - **Attributes**: ParticipantID (PK), Name, RoleID (FK), ProjectID (FK), ContactInfo
13. **Roles**:
    - **Attributes**: RoleID (PK), RoleName
14. **Communication**:
    - **Attributes**: CommunicationID (PK), ProjectID (FK), ParticipantID (FK), Date, Message, StatusID (FK)
15. **Status**:
    - **Attributes**: StatusID (PK), StatusDescription
16. **Standards**:
    - **Attributes**: StandardID (PK), StandardDescription, CategoryID (FK), ApplicableTo
17. **Inspections**:
    - **Attributes**: InspectionID (PK), ProjectID (FK), Date, InspectorID (FK), Result, Comments

Chapter 4: Implementation of Database

Revised DDL Scripts

```
– Inspectors Table
CREATE TABLE "conDB".Inspectors (
    InspectorID SERIAL PRIMARY KEY,
    InspectorName VARCHAR(255)
);
-- Roles Table
CREATE TABLE "conDB".Roles (
    RoleID SERIAL PRIMARY KEY,
    RoleName VARCHAR(255)
);
-- Clients Table
CREATE TABLE "conDB".Clients (
    ClientID SERIAL PRIMARY KEY,
    ClientName VARCHAR(255),
    ContactInfo VARCHAR(255)
);
-- Locations Table
CREATE TABLE "conDB".Locations (
    LocationID SERIAL PRIMARY KEY,
    LocationName VARCHAR(255)
);
-- Materials Table
CREATE TABLE "conDB".Materials (
    MaterialID SERIAL PRIMARY KEY,
    MaterialName VARCHAR(255)
);
-- Status Table
CREATE TABLE "conDB".Status (
    StatusID SERIAL PRIMARY KEY,
    StatusDescription VARCHAR(50)
);
-- Categories Table
CREATE TABLE "conDB".Categories (
    CategoryID SERIAL PRIMARY KEY,
    CategoryName VARCHAR(255)
);
```

```
-- Projects Table
CREATE TABLE "conDB".Projects (
    ProjectID SERIAL PRIMARY KEY,
    ProjectName VARCHAR(255),
    StartDate DATE,
    EndDate DATE,
    ClientID INT REFERENCES "conDB".Clients(ClientID),
    LocationID INT REFERENCES "conDB".Locations(LocationID),
    Status TEXT
);

-- Material_Project Table
CREATE TABLE "conDB".Material_Project (
    MaterialProjectID SERIAL PRIMARY KEY,
    MaterialID INT REFERENCES "conDB".Materials(MaterialID),
    ProjectID INT REFERENCES "conDB".Projects(ProjectID),
    Quantity INT,
    Unit VARCHAR(50),
    AvailabilityStatus VARCHAR(50)
);

-- Monitoring Tools Table
CREATE TABLE "conDB".MonitoringTools (
    ToolID SERIAL PRIMARY KEY,
    ToolName VARCHAR(255),
    MeasurementType VARCHAR(50)
);

-- Tool_Project Table
CREATE TABLE "conDB".Tool_Project (
    ToolProjectID SERIAL PRIMARY KEY,
    ToolID INT REFERENCES "conDB".MonitoringTools(ToolID),
    ProjectID INT REFERENCES "conDB".Projects(ProjectID),
    MeasurementValue DECIMAL(10, 2),
    Unit VARCHAR(50)
);
```

```
-- Costs & Budgets Table
CREATE TABLE "conDB".CostsAndBudgets (
    CostID SERIAL PRIMARY KEY,
    ProjectID INT REFERENCES "conDB".Projects(ProjectID),
    BudgetedCost DECIMAL(15, 2),
    ActualCost DECIMAL(15, 2),
    CategoryID INT REFERENCES "conDB".Categories(CategoryID),
    Date DATE
);

-- Quality Assurance Table
CREATE TABLE "conDB".QualityAssurance (
    CheckID SERIAL PRIMARY KEY,
    ProjectID INT REFERENCES "conDB".Projects(ProjectID),
    MaterialID INT REFERENCES "conDB".Materials(MaterialID),
    DateOfCheck DATE,
    ComplianceStatus VARCHAR(50),
    InspectorID INT REFERENCES "conDB".Inspectors(InspectorID)
);

-- Participants Table
CREATE TABLE "conDB".Participants (
    ParticipantID SERIAL PRIMARY KEY,
    Name VARCHAR(255),
    RoleID INT REFERENCES "conDB".Roles(RoleID),
    ProjectID INT REFERENCES "conDB".Projects(ProjectID),
    ContactInfo VARCHAR(255)
);

-- Communication Table
    CREATE TABLE "conDB".Communication (
        CommunicationID SERIAL PRIMARY KEY,
        ProjectID INT REFERENCES "conDB".Projects(ProjectID),
        ParticipantID INT REFERENCES "conDB".Participants(ParticipantID),
        Date DATE,
        Message TEXT,
        StatusID INT REFERENCES "conDB".Status(StatusID)
    );
```

```
-- Standards Table
CREATE TABLE "conDB".Standards (
    StandardID SERIAL PRIMARY KEY,
    StandardDescription TEXT,
    CategoryID INT REFERENCES "conDB".Categories(CategoryID),
    ApplicableTo VARCHAR(255)
);

-- Inspections Table
CREATE TABLE "conDB".Inspections (
    InspectionID SERIAL PRIMARY KEY,
    ProjectID INT REFERENCES "conDB".Projects(ProjectID),
    Date DATE,
    InspectorID INT REFERENCES "conDB".Inspectors(InspectorID),
    Result VARCHAR(50),
    Comments TEXT
);
```

Database Population

```
INSERT INTO "conDB".MonitoringTools (ToolID, ToolName, MeasurementType) VALUES
(1, 'Total Station', 'Distance/Angle Measurement'),
(2, 'Theodolite', 'Angle Measurement'),
(3, 'Leveling Instrument', 'Height Measurement'),
(4, 'GPS Equipment', 'Location Tracking'),
(5, 'Drones', 'Aerial Surveying'),
(6, 'Laser Scanner', '3D Data Capture'),
(7, 'Moisture Meter', 'Moisture Content'),
(8, 'Thermal Imaging Camera', 'Heat Measurement'),
(9, 'Concrete Maturity Sensor', 'Concrete Curing Monitoring'),
(10, 'Vibration Monitor', 'Vibration Measurement'),
(11, 'Load Cell', 'Weight Measurement'),
(12, 'Environmental Sensor', 'Air Quality Monitoring'),
(13, 'Camera System', 'Security Monitoring'),
(14, 'Smartphone Application', 'Site Management'),
(15, 'Quality Control Test Equipment', 'Material Testing'),
(16, 'BIM Software', 'Building Information Monitoring'),
(17, 'Water Level Indicator', 'Water Level Measurement'),
(18, 'Pavement Profiler', 'Road Surface Assessment'),
(19, 'Dust Monitor', 'Particulate Matter Measurement'),
(20, 'Site Safety Monitoring System', 'Safety Compliance Tracking');


INSERT INTO "conDB".Materials (MaterialID, MaterialName) VALUES
(1, 'Concrete'),
(2, 'Steel'),
(3, 'Wood'),
(4, 'Brick'),
(5, 'Cement'),
(6, 'Glass'),
(7, 'Aluminum'),
(8, 'Asphalt'),
(9, 'Stone'),
(10, 'Gypsum'),
(11, 'Fiberglass Insulation'),
(12, 'Plywood'),
(13, 'Tile'),
(14, 'Rebar'),
(15, 'Paint'),
(16, 'Drywall'),
(17, 'Mortar'),
```

```
(18, 'Aggregate'),
(19, 'PVC'),
(20, 'Fiber Cement Board');

INSERT INTO "conDB".Locations (LocationID, LocationName) VALUES
(1, 'Downtown Area'),
(2, 'Uptown Area'),
(3, 'Midtown Area'),
(4, 'Suburban Area'),
(5, 'Central Business District'),
(6, 'Green Park'),
(7, 'Industrial Zone'),
(8, 'Residential Zone A'),
(9, 'North West Suburb'),
(10, 'City Center'),
(11, 'Harbor District'),
(12, 'West End Commercial Hub'),
(13, 'East Side Technology Park'),
(14, 'South Side Housing Project'),
(15, 'Downtown Renewal Area'),
(16, 'Heritage Area'),
(17, 'Mixed-Use Development Area'),
(18, 'Retail District'),
(19, 'Logistics Park'),
(20, 'Business District');

INSERT INTO "conDB".Clients (ClientID, ClientName, ContactInfo) VALUES
(1, 'Larsen & Toubro Limited', 'contact@lt.com'),
(2, 'Tata Projects', 'info@tataprojects.com'),
(3, 'Shapoorji Pallonji Group', 'support@shapoorjipallonji.com'),
(4, 'GMR Group', 'contact@gmrgroup.in'),
(5, 'Hindustan Construction Company', 'info@hccindia.com'),
(6, 'Jaypee Group', 'support@jaypeegroup.com'),
(7, 'Sterling and Wilson', 'contact@sterlingwilson.com'),
(8, 'IRCON International', 'info@ircon.org'),
(9, 'Punj Lloyd', 'support@punjlloyd.com'),
(10, 'Gammon India', 'contact@gammonindia.com'),
(11, 'Bharat Heavy Electricals Limited', 'info@bhel.in'),
(12, 'KCC Buildcon', 'support@kccbuildcon.com'),
(13, 'Dilip Buildcon Limited', 'contact@dilipbuildcon.com'),
(14, 'M/s. Simplex Infrastructures', 'info@simplexgroup.com'),
(15, 'NCC Limited', 'support@nccindia.com'),
(16, 'Rai Bahadur Narain Das', 'contact@rbnd.com'),
(17, 'Siddhivinayak Construction', 'info@siddhivinayak.com'),
```

```
(18, 'Tata Housing Development Company', 'support@tatahousing.com'),
(19, 'SRS Real Infrastructure', 'contact@srsinfra.com'),
(20, 'Suntec India', 'info@suntecindia.com'),
(21, 'L & T Construction', 'support@ltconstruction.com'),
(22, 'Gujarat Pipavav Port', 'contact@gpp.com'),
(23, 'JMC Projects', 'info@jmcprojects.com'),
(24, 'B.L. Kashyap and Sons', 'support@blkashyap.com'),
(25, 'Mohanlal Sukhadia University', 'contact@mlsu.ac.in'),
(26, 'Nagarjuna Construction Company', 'info@nccindia.com'),
(27, 'HCC Ltd.', 'support@hccindia.com'),
(28, 'L&T Metro Rail', 'contact@ltmetrorail.com'),
(29, 'Kochi Water Metro', 'info@kochimetro.gov.in'),
(30, 'Unitech Limited', 'support@unitechlimited.com'),
(31, 'Rajiv Gandhi International Airport', 'contact@ghia.in'),
(32, 'Shree Cement Limited', 'info@shreecement.com'),
(33, 'Bharat Infrastructure', 'support@bharatinfrastructure.com'),
(34, 'Meyer Construction', 'contact@meyerconstruction.com'),
(35, 'IVRCL Limited', 'info@ivrcl.com'),
(36, 'C.E. Construction', 'support@ceconstruction.com'),
(37, 'Phoenix Infrastructure', 'contact@phoenixinfra.com'),
(38, 'Ruchira Construction', 'info@ruchiraconstruction.com'),
(39, 'Sam India Builtwell', 'support@samindiabuiltwell.com'),
(40, 'Wadhwa Group', 'contact@wadhwagroup.com'),
(41, 'Manohar B. Dhanuka', 'info@mbd.com'),
(42, 'K.P. Suresh', 'support@kpsuresh.com'),
(43, 'Larsen & Toubro Limited', 'contact@larsentoubro.com'),
(44, 'D.R. Agarwal', 'info@dragrawal.com'),
(45, 'Infrastructure Development Corporation', 'support@idcl.com'),
(46, 'Ravi Infrastructure', 'contact@raviinfra.com'),
(47, 'Agarwal Construction', 'info@agarwalconstruction.com'),
(48, 'Accenture Construction', 'support@accentureconstruction.com'),
(49, 'Shivani Constructions', 'contact@shivaniconstructions.com'),
(50, 'Vishnu Builders', 'info@vishnubuilders.com');


INSERT INTO "conDB".Roles (RoleName)
VALUES
    ('Accountant'),
    ('Inventory Manager'),
    ('Contractor'),
    ('Labourer'),
    ('Architect'),
    ('Site Manager'),
    ('Client'),
```

```
    ('Logistics Head'),
    ('Clerk');


INSERT INTO "conDB".Status (StatusID, StatusDescription) VALUES
(1, 'Unread'),
(2, 'Read'),
(3, 'Replied'),
(4, 'Follow-up Required'),
(5, 'Archived'),
(6, 'Action Taken'),
(7, 'Escalated'),
(8, 'Pending Review'),
(9, 'Closed'),
(10, 'Flagged');



INSERT INTO "conDB".Categories (CategoryID, CategoryName) VALUES
(1, 'Labor Costs'),
(2, 'Material Costs'),
(3, 'Equipment Rental'),
(4, 'Subcontractor Fees'),
(5, 'Permits and Licenses'),
(6, 'Site Preparation'),
(7, 'Structural Work'),
(8, 'Electrical Work'),
(9, 'Plumbing'),
(10, 'Safety Equipment');

INSERT INTO "conDB".Inspectors (InspectorName)
VALUES
    ('John Doe'),
    ('Jane Smith'),
    ('Emily Davis'),
    ('Johnson Derby'),
    ('Jonathan Smith'),
    ('Emily Riley'),
    ('Akshay Solanki'),
    ('Dinesh Solanki'),
    ('Manish Malhotra'),
    ('Bruce Wayne'),
    ('Peter Pan'),
    ('Om Puri'),
```

```
    ('Emily Davis'),
    ('Johnson Derby'),
    ('Jonathan Smith'),
    ('Emily Riley'),
    ('Akshay Solanki'),
    ('Dinesh Solanki'),
    ('Manish Malhotra'),
    ('Bruce Wayne'),
    ('Peter Pan'),
    ('Om Puri');

INSERT INTO "conDB".Standards (StandardID, StandardDescription, CategoryID,
ApplicableTo) VALUES
(1, 'Fair wage and working hours for laborers', 1, 'All'),
(2, 'Material quality and sourcing regulations', 2, 'All'),
(3, 'Safety and operational standards for rented equipment', 3, 'All'),
(4, 'Subcontractor agreements and timely payments', 4, 'All'),
(5, 'Compliance with permits and licenses', 5, 'All'),
(6, 'Environmental and safety standards for site preparation', 6, 'Commercial'),
(7, 'Structural integrity and compliance with building codes', 7, 'All'),
(8, 'Electrical safety and installation requirements', 8, 'All'),
(9, 'Plumbing standards for water safety', 9, 'Residential'),
(10, 'PPE and on-site safety regulations', 10, 'Industrial');


INSERT INTO "conDB".Projects (ProjectName, StartDate, EndDate, ClientID, LocationID,
Status)
VALUES
    ('Residential Complex Phase I', '2023-01-15', '2025-12-31', 12, 3, 'Planned'),
    ('Highway Expansion Project', '2023-03-01', '2024-11-15', 25, 7, 'In Progress'),
    ('Corporate Office Park', '2024-02-10', '2026-05-20', 41, 12, 'Completed'),
    ('Metro Line Extension', '2023-04-20', '2025-09-10', 33, 18, 'Planned'),
    ('Shopping Mall Development', '2023-07-05', '2025-03-30', 9, 5, 'In Progress'),
    ('School Campus Construction', '2024-01-01', '2026-02-28', 18, 10, 'Completed'),
    ('Luxury Apartment Tower', '2023-10-15', '2025-08-20', 27, 6, 'Planned'),
    ('Healthcare Facility', '2024-03-12', '2026-01-15', 31, 13, 'In Progress'),
    ('Industrial Park Development', '2023-08-20', '2026-03-10', 7, 14, 'Completed'),
    ('Airport Terminal Expansion', '2024-05-01', '2027-02-28', 50, 19, 'Planned'),
    ('Solar Power Plant', '2023-06-01', '2025-11-15', 22, 16, 'In Progress'),
    ('Hydroelectric Dam Construction', '2023-02-10', '2025-12-25', 14, 2, 'Completed'),
    ('IT Park Development', '2023-09-05', '2026-07-31', 38, 8, 'Planned'),
    ('Green Housing Project', '2024-04-15', '2026-11-30', 29, 11, 'In Progress'),
    ('Urban Revitalization', '2023-07-12', '2025-12-20', 3, 15, 'Completed'),
    ('Railway Station Upgrade', '2024-06-10', '2027-01-01', 36, 20, 'In Progress'),
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    ('Residential Tower Complex', '2023-03-25', '2025-10-15', 45, 9, 'Planned'),
    ('Public Park Renovation', '2024-09-20', '2026-04-30', 15, 4, 'Completed'),
    ('Suburban Housing Development', '2023-05-18', '2025-08-05', 8, 1, 'In Progress'),
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INSERT INTO "conDB".Participants (Name, RoleID, ProjectID,contactinfo) VALUES
 ('Kimberly Elise', '4', '4','Kimberly Elise1993@gmail.com'),
 ('Marcia McBroom', '9', '2','Marcia McBroom2000@gmail.com'),
 ('Travis Oates', '5', '7','Travis Oates1998@gmail.com'),
 ('Klaus Wennemann', '2', '9','Klaus Wennemann1998@gmail.com'),
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('Robert Ryan', '6', '4','Robert Ryan2004@gmail.com'),
('Bruno Campos', '4', '4','Bruno Campos2001@gmail.com'),
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('Ethan Suplee', '7', '6','Ethan Suplee1990@gmail.com'),
('Jim Broadbent', '6', '1','Jim Broadbent1992@gmail.com'),
('Burt Young', '5', '2','Burt Young1996@gmail.com'),
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('Harvey Keitel', '5', '7','Harvey Keitel2010@gmail.com'),
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('Amy Stewart', '2', '2','Amy Stewart2004@gmail.com'),
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('Charlie Yeung', '3', '6','Charlie Yeung2002@gmail.com'),
('Brit Marling', '5', '5','Brit Marling1996@gmail.com'),
('Carey Mulligan', '2', '5','Carey Mulligan2003@gmail.com'),
('Joshua Leonard', '7', '6','Joshua Leonard1994@gmail.com'),
('Victoria Beckham', '6', '9','Victoria Beckham1999@gmail.com'),
('Lili Taylor', '6', '3','Lili Taylor1996@gmail.com'),
('Henry Bergman', '6', '4','Henry Bergman1998@gmail.com'),
('Sonja Smits', '1', '9','Sonja Smits1997@gmail.com'),
('Michael Peña', '5', '4','Michael Peña2006@gmail.com'),
('Matthew Perry', '2', '1','Matthew Perry2001@gmail.com'),
('Gwyneth Paltrow', '9', '3','Gwyneth Paltrow2000@gmail.com'),
('Jonny Lee Miller', '3', '7','Jonny Lee Miller1993@gmail.com'),
('Valerie Red-Horse', '2', '9','Valerie Red-Horse1997@gmail.com'),
('Brad Dourif', '9', '1','Brad Dourif2005@gmail.com'),
('Wilt Chamberlain', '5', '9','Wilt Chamberlain2005@gmail.com'),
('Rob Devaney', '9', '7','Rob Devaney1994@gmail.com'),
('Shelley Winters', '1', '1','Shelley Winters1999@gmail.com'),
('Herbert Knaup', '4', '1','Herbert Knaup2006@gmail.com'),
('Jennifer Paige', '7', '4','Jennifer Paige1995@gmail.com'),
('Casper Van Dien', '1', '3','Casper Van Dien1999@gmail.com'),
('Ben Browder', '2', '3','Ben Browder1992@gmail.com'),
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('John Glover', '5', '2','John Glover2003@gmail.com'),
('Om Puri', '3', '3','Om Puri2001@gmail.com'),
('Hank Azaria', '3', '5','Hank Azaria1995@gmail.com'),
('Nona Gaye', '3', '4','Nona Gaye2010@gmail.com'),
('Faye Wong', '7', '3','Faye Wong1999@gmail.com'),
('Adam Sandler', '2', '4','Adam Sandler1999@gmail.com'),
('Imogen Poots', '6', '4','Imogen Poots2009@gmail.com'),
('Edward James Olmos', '3', '5','Edward James Olmos1996@gmail.com'),
('Gao Yuanyuan', '4', '4','Gao Yuanyuan2006@gmail.com'),

('Bruno Ganz', '7', '4','Bruno Ganz2007@gmail.com'),
('Errol Flynn', '3', '6','Errol Flynn2009@gmail.com'),
('Debbie Reynolds', '4', '6','Debbie Reynolds2005@gmail.com'),
('Randy Quaid', '6', '4','Randy Quaid2009@gmail.com'),
('Renee Olstead', '1', '4','Renee Olstead1991@gmail.com'),
('Peter Dinklage', '3', '1','Peter Dinklage2004@gmail.com'),
('Oliver Cooper', '5', '4','Oliver Cooper1996@gmail.com'),
('Shavar Ross', '5', '9','Shavar Ross2008@gmail.com'),
('Seth MacFarlane', '7', '6','Seth MacFarlane1995@gmail.com'),
('Dave Parnell', '4', '4','Dave Parnell1991@gmail.com'),
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('Elpidia Carrillo', '2', '4','Elpidia Carrillo1999@gmail.com'),
('Wang Xue-qi', '3', '2','Wang Xue-qi1997@gmail.com'),
('Ann Miller', '5', '4','Ann Miller1997@gmail.com'),
('Jason Cope', '5', '3','Jason Cope2005@gmail.com'),
('Donald Sutherland', '9', '4','Donald Sutherland2009@gmail.com'),
('Taye Diggs', '4', '4','Taye Diggs1990@gmail.com'),
('Jeremy Sisto', '1', '3','Jeremy Sisto2007@gmail.com'),
('Colm Meaney', '7', '4','Colm Meaney2000@gmail.com'),
('Richard Norton', '4', '5','Richard Norton2010@gmail.com'),
('Petchtai Wongkamlao', '7', '6','Petchtai Wongkamlao1995@gmail.com'),
('Peter Ostrum', '4', '9','Peter Ostrum2010@gmail.com'),
('Richard Roundtree', '4', '6','Richard Roundtree2006@gmail.com'),
('Joan Chen', '5', '9','Joan Chen1995@gmail.com'),
('Christopher Curry', '7', '4','Christopher Curry1993@gmail.com'),
('Matthew Macfadyen', '5', '7','Matthew Macfadyen2008@gmail.com'),
('George Cole', '9', '4','George Cole1997@gmail.com'),
('Vladimir Menshov', '4', '6','Vladimir Menshov2010@gmail.com'),
('Alicja Bachleda-Curuś', '6', '5','Alicja Bachleda-Curuś2009@gmail.com'),
('Barbra Streisand', '3', '9','Barbra Streisand1990@gmail.com'),
('Richard E. Grant', '9', '1','Richard E. Grant2009@gmail.com'),
('Roy Scheider', '3', '3','Roy Scheider2000@gmail.com'),
('Demi Moore', '5', '4','Demi Moore2002@gmail.com'),
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('Malin Åkerman', '7', '4','Malin Åkerman2005@gmail.com'),
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('John Larroquette', '6', '5','John Larroquette2000@gmail.com'),
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('Yūko Tanaka', '5', '7','Yūko Tanaka1995@gmail.com'),
('Anne Archer', '5', '3','Anne Archer1996@gmail.com'),
('Ariana Richards', '3', '7','Ariana Richards1991@gmail.com'),
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('Tom Holland', '3', '5','Tom Holland1992@gmail.com'),
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('Steve Sandvoss', '1', '6','Steve Sandvoss2004@gmail.com'),
('Cate Blanchett', '3', '4','Cate Blanchett2010@gmail.com');

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   (1, 400000.00, 390000.00, 7, '2024-04-01'),   -- Utilities
   (1, 100000.00, 95000.00, 8, '2024-04-20'),    -- Insurance
   (1, 500000.00, 480000.00, 9, '2024-05-10'),   -- Permits
   (1, 750000.00, 730000.00, 10, '2024-05-25');  -- Miscellaneous
-- CostsAndBudgets Table for ProjectID 2
INSERT INTO "conDB".CostsAndBudgets (ProjectID, BudgetedCost, ActualCost, CategoryID,
Date)
VALUES
   (2, 175000.00, 170000.00, 1, '2024-01-15'),   -- Labor
   (2, 320000.00, 315000.00, 2, '2024-02-05'),   -- Materials
   (2, 215000.00, 210000.00, 3, '2024-03-10'),   -- Equipment
   (2, 130000.00, 125000.00, 4, '2024-04-12'),   -- Safety
   (2, 195000.00, 190000.00, 5, '2024-05-18'),   -- Transportation
   (2, 270000.00, 265000.00, 6, '2024-06-07'),   -- Subcontractors
   (2, 420000.00, 410000.00, 7, '2024-07-15'),   -- Utilities
   (2, 110000.00, 108000.00, 8, '2024-08-02'),   -- Insurance
   (2, 530000.00, 525000.00, 9, '2024-09-20'),   -- Permits
   (2, 780000.00, 770000.00, 10, '2024-10-10');  -- Miscellaneous

-- CostsAndBudgets Table for ProjectID 3
INSERT INTO "conDB".CostsAndBudgets (ProjectID, BudgetedCost, ActualCost, CategoryID,
Date)
VALUES
   (3, 160000.00, 155000.00, 1, '2024-01-25'),   -- Labor
   (3, 310000.00, 300000.00, 2, '2024-02-20'),   -- Materials
   (3, 230000.00, 225000.00, 3, '2024-03-18'),   -- Equipment
   (3, 125000.00, 120000.00, 4, '2024-04-10'),   -- Safety
   (3, 185000.00, 180000.00, 5, '2024-05-12'),   -- Transportation
   (3, 255000.00, 250000.00, 6, '2024-06-22'),   -- Subcontractors
   (3, 410000.00, 405000.00, 7, '2024-07-25'),   -- Utilities
   (3, 95000.00, 94000.00, 8, '2024-08-14'),     -- Insurance
   (3, 520000.00, 510000.00, 9, '2024-09-10'),   -- Permits
   (3, 760000.00, 750000.00, 10, '2024-10-05');  -- Miscellaneous
```

```
-- CostsAndBudgets Table for ProjectID 4
INSERT INTO "conDB".CostsAndBudgets (ProjectID, BudgetedCost, ActualCost, CategoryID,
Date)
VALUES
    (4, 155000.00, 150000.00, 1, '2024-01-15'),   -- Labor
    (4, 305000.00, 295000.00, 2, '2024-02-07'),   -- Materials
    (4, 220000.00, 215000.00, 3, '2024-03-12'),   -- Equipment
    (4, 135000.00, 130000.00, 4, '2024-04-17'),   -- Safety
    (4, 175000.00, 170000.00, 5, '2024-05-24'),   -- Transportation
    (4, 265000.00, 260000.00, 6, '2024-06-10'),   -- Subcontractors
    (4, 400000.00, 395000.00, 7, '2024-07-18'),   -- Utilities
    (4, 120000.00, 115000.00, 8, '2024-08-05'),   -- Insurance
    (4, 480000.00, 470000.00, 9, '2024-09-28'),   -- Permits
    (4, 720000.00, 710000.00, 10, '2024-10-20');  -- Miscellaneous

-- CostsAndBudgets Table for ProjectID 5
INSERT INTO "conDB".CostsAndBudgets (ProjectID, BudgetedCost, ActualCost, CategoryID,
Date)
VALUES
    (5, 165000.00, 160000.00, 1, '2024-01-18'),   -- Labor
    (5, 315000.00, 310000.00, 2, '2024-02-10'),   -- Materials
    (5, 235000.00, 230000.00, 3, '2024-03-08'),   -- Equipment
    (5, 140000.00, 135000.00, 4, '2024-04-22'),   -- Safety
    (5, 185000.00, 180000.00, 5, '2024-05-05'),   -- Transportation
    (5, 275000.00, 270000.00, 6, '2024-06-15'),   -- Subcontractors
    (5, 405000.00, 400000.00, 7, '2024-07-01'),   -- Utilities
    (5, 115000.00, 110000.00, 8, '2024-08-12'),   -- Insurance
    (5, 495000.00, 490000.00, 9, '2024-09-25'),   -- Permits
    (5, 710000.00, 700000.00, 10, '2024-10-11');  -- Miscellaneous

-- CostsAndBudgets Table for ProjectID 6
INSERT INTO "conDB".CostsAndBudgets (ProjectID, BudgetedCost, ActualCost, CategoryID,
Date)
VALUES
    (6, 170000.00, 165000.00, 1, '2024-01-08'),   -- Labor
    (6, 325000.00, 320000.00, 2, '2024-02-12'),   -- Materials
    (6, 245000.00, 240000.00, 3, '2024-03-25'),   -- Equipment
    (6, 145000.00, 140000.00, 4, '2024-04-05'),   -- Safety
    (6, 190000.00, 185000.00, 5, '2024-05-18'),   -- Transportation
    (6, 285000.00, 280000.00, 6, '2024-06-22'),   -- Subcontractors
    (6, 415000.00, 410000.00, 7, '2024-07-15'),   -- Utilities
    (6, 125000.00, 120000.00, 8, '2024-08-07'),   -- Insurance
    (6, 510000.00, 505000.00, 9, '2024-09-11'),   -- Permits
```

```
    (6, 720000.00, 710000.00, 10, '2024-10-02');  -- Miscellaneous

-- CostsAndBudgets Table for ProjectID 7
INSERT INTO "conDB".CostsAndBudgets (ProjectID, BudgetedCost, ActualCost, CategoryID,
Date)
VALUES
    (7, 180000.00, 175000.00, 1, '2024-01-20'),   -- Labor
    (7, 340000.00, 335000.00, 2, '2024-02-25'),   -- Materials
    (7, 250000.00, 245000.00, 3, '2024-03-10'),   -- Equipment
    (7, 135000.00, 130000.00, 4, '2024-04-18'),   -- Safety
    (7, 200000.00, 195000.00, 5, '2024-05-22'),   -- Transportation
    (7, 270000.00, 265000.00, 6, '2024-06-03'),   -- Subcontractors
    (7, 425000.00, 420000.00, 7, '2024-07-10'),   -- Utilities
    (7, 140000.00, 135000.00, 8, '2024-08-19'),   -- Insurance
    (7, 530000.00, 525000.00, 9, '2024-09-05'),   -- Permits
    (7, 755000.00, 750000.00, 10, '2024-10-15');  -- Miscellaneous

-- CostsAndBudgets Table for ProjectID 8
INSERT INTO "conDB".CostsAndBudgets (ProjectID, BudgetedCost, ActualCost, CategoryID,
Date)
VALUES
    (8, 185000.00, 180000.00, 1, '2024-01-12'),   -- Labor
    (8, 345000.00, 340000.00, 2, '2024-02-15'),   -- Materials
    (8, 255000.00, 250000.00, 3, '2024-03-05'),   -- Equipment
    (8, 145000.00, 140000.00, 4, '2024-04-20'),   -- Safety
    (8, 210000.00, 205000.00, 5, '2024-05-30'),   -- Transportation
    (8, 280000.00, 275000.00, 6, '2024-06-25'),   -- Subcontractors
    (8, 435000.00, 430000.00, 7, '2024-07-15'),   -- Utilities
    (8, 155000.00, 150000.00, 8, '2024-08-10'),   -- Insurance
    (8, 540000.00, 535000.00, 9, '2024-09-22'),   -- Permits
    (8, 765000.00, 760000.00, 10, '2024-10-18');  -- Miscellaneous

-- CostsAndBudgets Table for ProjectID 9
INSERT INTO "conDB".CostsAndBudgets (ProjectID, BudgetedCost, ActualCost, CategoryID,
Date)
VALUES
    (9, 190000.00, 185000.00, 1, '2024-01-22'),   -- Labor
    (9, 355000.00, 350000.00, 2, '2024-02-18'),   -- Materials
    (9, 265000.00, 260000.00, 3, '2024-03-14'),   -- Equipment
    (9, 150000.00, 145000.00, 4, '2024-04-11'),   -- Safety
    (9, 220000.00, 215000.00, 5, '2024-05-29'),   -- Transportation
    (9, 290000.00, 285000.00, 6, '2024-06-19'),   -- Subcontractors
    (9, 445000.00, 440000.00, 7, '2024-07-25'),   -- Utilities
    (9, 160000.00, 155000.00, 8, '2024-08-14'),   -- Insurance
```

```
    (9, 550000.00, 545000.00, 9, '2024-09-28'),   -- Permits
    (9, 775000.00, 770000.00, 10, '2024-10-09');  -- Miscellaneous

-- CostsAndBudgets Table for ProjectID 10
INSERT INTO "conDB".CostsAndBudgets (ProjectID, BudgetedCost, ActualCost, CategoryID,
Date)
VALUES
    (10, 200000.00, 195000.00, 1, '2024-01-05'),  -- Labor
    (10, 365000.00, 360000.00, 2, '2024-02-25'),  -- Materials
    (10, 275000.00, 270000.00, 3, '2024-03-09'),  -- Equipment
    (10, 155000.00, 150000.00, 4, '2024-04-03'),  -- Safety
    (10, 230000.00, 225000.00, 5, '2024-05-15'),  -- Transportation
    (10, 295000.00, 290000.00, 6, '2024-06-02'),  -- Subcontractors
    (10, 455000.00, 450000.00, 7, '2024-07-20'),  -- Utilities
    (10, 165000.00, 160000.00, 8, '2024-08-30'),  -- Insurance
    (10, 560000.00, 555000.00, 9, '2024-09-17'),  -- Permits
    (10, 785000.00, 780000.00, 10, '2024-10-29'); -- Miscellaneous


INSERT INTO "conDB".Inspections (InspectionID, ProjectID, Date, InspectorID, Result,
Comments) VALUES
(1, 1, '2024-11-01', 3, 'Pass', 'Initial inspection completed successfully.'),
(2, 1, '2024-11-10', 5, 'Fail', 'Minor structural adjustments required.'),
(3, 2, '2024-11-02', 6, 'Pass', 'Safety compliance verified.'),
(4, 2, '2024-11-12', 7, 'Pass', 'Final inspection before approval.'),
(5, 3, '2024-11-03', 8, 'Fail', 'Foundation check failed. Reinforcement needed.'),
(6, 4, '2024-11-04', 2, 'Pass', 'Material quality standards met.'),
(7, 5, '2024-11-05', 9, 'Pass', 'Site inspection passed.'),
(8, 5, '2024-11-15', 11, 'Pass', 'Safety measures confirmed post adjustments.'),
(9, 6, '2024-11-06', 1, 'Pass', 'Equipment calibration verified.'),
(10, 6, '2024-11-17', 4, 'Pass', 'Routine inspection completed.'),
(11, 7, '2024-11-07', 3, 'Fail', 'Electrical setup needs revision.'),
(12, 7, '2024-11-18', 10, 'Pass', 'Electrical re-inspection approved.'),
(13, 8, '2024-11-08', 5, 'Pass', 'Environmental standards met.'),
(14, 9, '2024-11-09', 12, 'Pass', 'Material storage verified for compliance.'),
(15, 10, '2024-11-10', 2, 'Pass', 'Structural integrity validated.'),
(16, 10, '2024-11-20', 8, 'Fail', 'Minor adjustments needed in roofing.'),
(17, 11, '2024-11-11', 4, 'Fail', 'Workplace safety requires improvement.'),
(18, 12, '2024-11-12', 7, 'Pass', 'Plumbing connections inspected and approved.'),
(19, 13, '2024-11-13', 6, 'Pass', 'Quality check passed for concrete works.'),
(20, 14, '2024-11-14', 9, 'Fail', 'Documentation review incomplete.'),
(21, 14, '2024-11-21', 3, 'Pass', 'Final approval after corrections.'),
(22, 15, '2024-11-15', 11, 'Pass', 'Inspection for compliance with permits.'),
(23, 15, '2024-11-25', 5, 'Pass', 'Final inspection passed.'),
```

```
(24, 16, '2024-11-16', 1, 'Pass', 'Routine safety inspection approved.'),
(25, 17, '2024-11-17', 12, 'Pass', 'Site cleared for next phase.'),
(26, 18, '2024-11-18', 6, 'Pass', 'Equipment safety checks completed.'),
(27, 18, '2024-11-28', 8, 'Fail', 'Minor repairs needed on heavy machinery.'),
(28, 19, '2024-11-19', 10, 'Pass', 'Structural framework inspected.'),
(29, 20, '2024-11-20', 2, 'Fail', 'Issues found in finishing work.'),
(30, 20, '2024-11-29', 7, 'Pass', 'Final inspection approved after corrections.');

INSERT INTO "conDB".Tool_Project (ToolID, ProjectID, MeasurementValue, Unit) VALUES
(1, 1, 150.5, 'meters'),
(2, 1, 28.2, 'degrees'),
(3, 2, 32.0, 'centimeters'),
(4, 3, 70.0, 'square meters'),
(5, 3, 1.2, 'hours'),
(6, 4, 4.5, 'percent'),
(7, 5, 15.0, 'degrees Celsius'),
(8, 5, 22.0, 'units'),
(9, 6, 12.0, 'percentage'),
(10, 6, 28.0, 'meters'),
(11, 7, 1750.0, 'kg'),
(12, 8, 18.0, 'degrees Celsius'),
(13, 9, 4.0, 'days'),
(14, 10, 60.0, 'units'),
(15, 11, 8.0, 'meters'),
(16, 12, 50.0, 'units'),
(17, 13, 9.0, 'units'),
(18, 14, 2.0, 'units'),
(19, 15, 85.0, 'degrees'),
(20, 16, 15.5, 'centimeters'),
(1, 17, 250.0, 'meters'),
(2, 18, 33.0, 'degrees'),
(3, 19, 19.5, 'centimeters'),
(4, 20, 55.0, 'units'),
(5, 1, 20.0, 'hours'),
(6, 2, 125.0, 'square meters'),
(7, 3, 8.0, 'days'),
(8, 4, 75.0, 'kg'),
(9, 5, 35.0, 'units'),
(10, 6, 30.0, 'degrees Celsius'),
(11, 7, 3.0, 'percent'),
(12, 8, 11.0, 'units'),
(13, 9, 90.0, 'units'),
(14, 10, 310.0, 'kilograms'),
(15, 11, 2.5, 'days'),
```

```
(1, 12, 50.5, 'meters'),
(2, 1, 34.2, 'degrees'),
(3, 2, 21.0, 'centimeters'),
(4, 3, 45.0, 'square meters'),
(5, 4, 1.0, 'hours'),
(6, 5, 5.5, 'percent'),
(7, 6, 27.0, 'units'),
(8, 7, 18.5, 'degrees Celsius'),
(9, 8, 12.0, 'days'),
(10, 9, 47.0, 'units'),
(11, 10, 65.0, 'units'),
(12, 11, 70.0, 'meters'),
(13, 12, 25.0, 'units'),
(14, 13, 22.0, 'units'),
(15, 14, 10.5, 'units'),
(16, 15, 6.5, 'degrees'),
(17, 16, 30.5, 'centimeters'),
(18, 17, 40.0, 'meters'),
(19, 18, 8.0, 'degrees'),
(20, 19, 15.0, 'centimeters'),
(1, 20, 2.0, 'units'),
(2, 1, 9.5, 'units'),
(3, 2, 20.0, 'units'),
(4, 3, 38.0, 'units'),
(5, 4, 55.0, 'units'),
(6, 5, 29.0, 'units'),
(7, 6, 100.0, 'meters'),
(8, 7, 14.0, 'degrees Celsius');



INSERT INTO "conDB".QualityAssurance (CheckID, ProjectID, MaterialID, DateOfCheck,
ComplianceStatus, InspectorID) VALUES
(1, 1, 2, '2024-01-15', 'Compliant', 1),
(2, 1, 5, '2024-01-20', 'Non-Compliant', 2),
(3, 2, 8, '2024-02-05', 'Compliant', 1),
(4, 3, 4, '2024-02-11', 'Compliant', 3),
(5, 3, 1, '2024-02-19', 'Non-Compliant', 4),
(6, 4, 6, '2024-03-02', 'Compliant', 5),
(7, 4, 10, '2024-03-10', 'Non-Compliant', 6),
(8, 5, 3, '2024-03-15', 'Compliant', 1),
(9, 5, 9, '2024-03-22', 'Compliant', 7),
(10, 6, 12, '2024-04-01', 'Non-Compliant', 8),
(11, 7, 14, '2024-04-10', 'Compliant', 5),
```

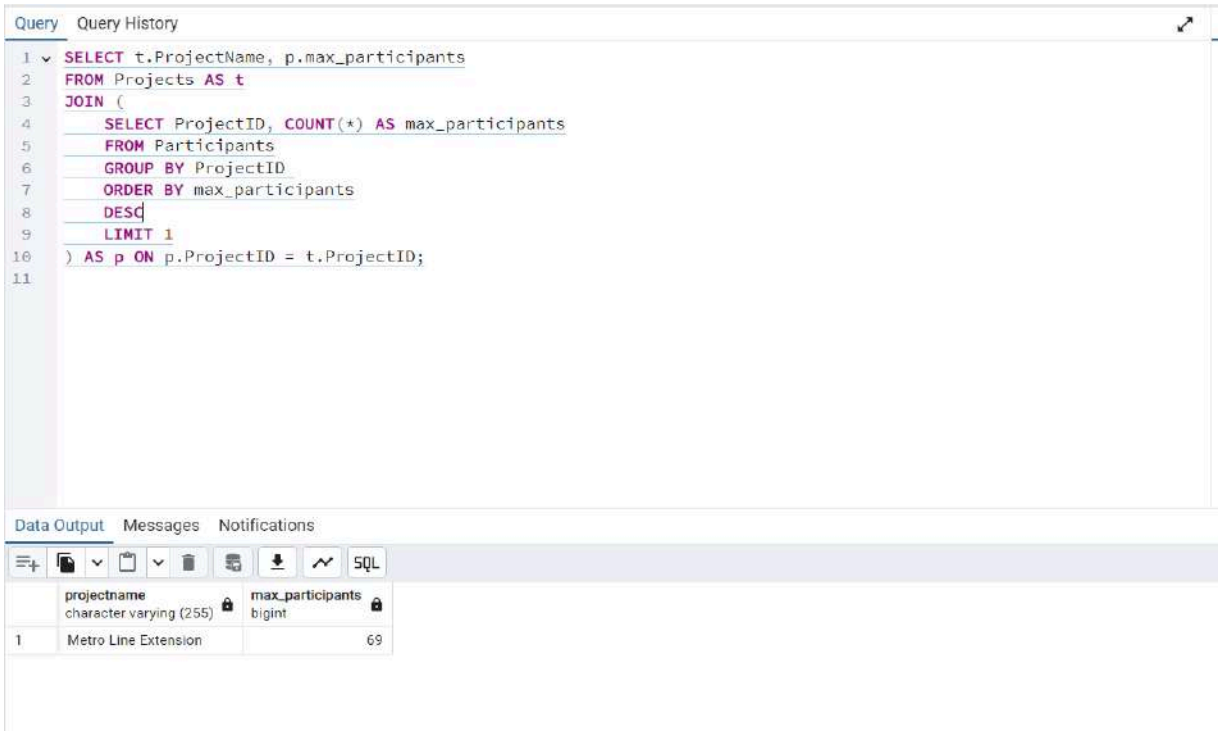
```
(12, 7, 16, '2024-04-15', 'Compliant', 9),
(13, 8, 11, '2024-04-20', 'Non-Compliant', 4),
(14, 9, 15, '2024-04-25', 'Compliant', 6),
(15, 9, 20, '2024-05-01', 'Compliant', 3),
(16, 10, 7, '2024-05-05', 'Compliant', 2),
(17, 11, 8, '2024-05-15', 'Non-Compliant', 7),
(18, 12, 1, '2024-05-20', 'Compliant', 1),
(19, 13, 4, '2024-06-01', 'Compliant', 2),
(20, 14, 5, '2024-06-05', 'Non-Compliant', 8),
(21, 15, 2, '2024-06-10', 'Compliant', 3),
(22, 16, 9, '2024-06-15', 'Compliant', 4),
(23, 17, 3, '2024-01-03', 'Non-Compliant', 5),
(24, 18, 6, '2024-02-25', 'Compliant', 6),
(25, 19, 12, '2024-03-12', 'Non-Compliant', 7),
(26, 20, 15, '2024-04-05', 'Compliant', 8),
(27, 20, 18, '2024-05-18', 'Non-Compliant', 1),
(28, 19, 14, '2024-06-01', 'Compliant', 2),
(29, 17, 7, '2024-01-25', 'Compliant', 3),
(30, 16, 13, '2024-02-10', 'Non-Compliant', 4),
(31, 15, 11, '2024-03-30', 'Compliant', 5),
(32, 14, 8, '2024-04-15', 'Compliant', 6),
(33, 13, 3, '2024-05-20', 'Non-Compliant', 7),
(34, 12, 5, '2024-06-12', 'Compliant', 8),
(35, 11, 10, '2024-06-18', 'Compliant', 9),
(36, 10, 1, '2024-01-10', 'Compliant', 2),
(37, 9, 9, '2024-02-05', 'Non-Compliant', 10),
(38, 8, 4, '2024-03-20', 'Compliant', 11),
(39, 7, 14, '2024-04-07', 'Compliant', 1),
(40, 6, 16, '2024-05-11', 'Non-Compliant', 12),
(41, 5, 2, '2024-01-30', 'Compliant', 3),
(42, 4, 20, '2024-02-22', 'Compliant', 4),
(43, 3, 15, '2024-03-01', 'Non-Compliant', 5),
(44, 2, 12, '2024-04-25', 'Compliant', 6),
(45, 1, 17, '2024-05-30', 'Non-Compliant', 7),
(46, 1, 11, '2024-06-07', 'Compliant', 8),
(47, 2, 6, '2024-01-18', 'Compliant', 9),
(48, 3, 5, '2024-02-12', 'Non-Compliant', 10),
(49, 4, 19, '2024-03-13', 'Compliant', 11),
(50, 5, 18, '2024-04-30', 'Compliant', 12);

-- Material_Project Table Insert Statements with Randomized AvailabilityStatus
INSERT INTO "conDB".Material_Project (MaterialID, ProjectID, Quantity, Unit,
AvailabilityStatus)
VALUES
```

(1, 3, 500, 'kg', 'In Stock'),
(2, 5, 250, 'liters', 'Out of Stock'),
(3, 7, 1000, 'pieces', 'Reserved'),
(4, 1, 1200, 'kg', 'Low Stock'),
(5, 9, 700, 'liters', 'In Use'),
(6, 2, 1500, 'pieces', 'Under Inspection'),
(7, 4, 800, 'kg', 'Damaged'),
(8, 6, 600, 'liters', 'Reserved'),
(9, 8, 750, 'kg', 'In Stock'),
(10, 10, 900, 'pieces', 'Low Stock'),
(11, 12, 1100, 'kg', 'In Use'),
(12, 14, 500, 'liters', 'Under Inspection'),
(13, 16, 1300, 'kg', 'Out of Stock'),
(14, 18, 400, 'pieces', 'Reserved'),
(15, 20, 900, 'kg', 'Damaged'),
(16, 11, 1000, 'kg', 'In Stock'),
(17, 13, 600, 'liters', 'Low Stock'),
(18, 15, 700, 'pieces', 'Reserved'),
(19, 17, 450, 'kg', 'In Use'),
(20, 19, 1150, 'liters', 'In Stock'),
(3, 2, 550, 'kg', 'Under Inspection'),
(7, 4, 300, 'liters', 'Damaged'),
(8, 6, 980, 'pieces', 'Out of Stock'),
(13, 9, 620, 'kg', 'Reserved'),
(15, 5, 870, 'kg', 'Low Stock'),
(6, 8, 660, 'liters', 'In Stock'),
(11, 10, 720, 'kg', 'In Use'),
(9, 1, 530, 'kg', 'Under Inspection'),
(5, 3, 410, 'pieces', 'Damaged'),
(2, 13, 700, 'liters', 'In Stock'),
(12, 15, 540, 'kg', 'Low Stock'),
(14, 7, 670, 'pieces', 'Reserved'),
(4, 16, 380, 'kg', 'In Stock'),
(8, 19, 960, 'liters', 'In Use'),
(10, 17, 580, 'kg', 'Out of Stock'),
(18, 4, 450, 'pieces', 'Damaged'),
(17, 6, 340, 'liters', 'In Stock'),
(13, 14, 550, 'kg', 'Under Inspection'),
(3, 9, 810, 'kg', 'Reserved'),
(15, 5, 620, 'pieces', 'In Use'),
(20, 8, 790, 'liters', 'Low Stock'),
(7, 12, 680, 'kg', 'Damaged'),
(19, 11, 850, 'pieces', 'Out of Stock'),
(2, 10, 490, 'kg', 'In Stock'),

```
(1, 13, 530, 'liters', 'Reserved'),
(6, 18, 610, 'kg', 'Low Stock'),
(9, 20, 720, 'pieces', 'In Use'),
(16, 15, 510, 'liters', 'Damaged'),
(4, 3, 840, 'kg', 'Under Inspection'),
(5, 7, 450, 'pieces', 'In Stock');
```

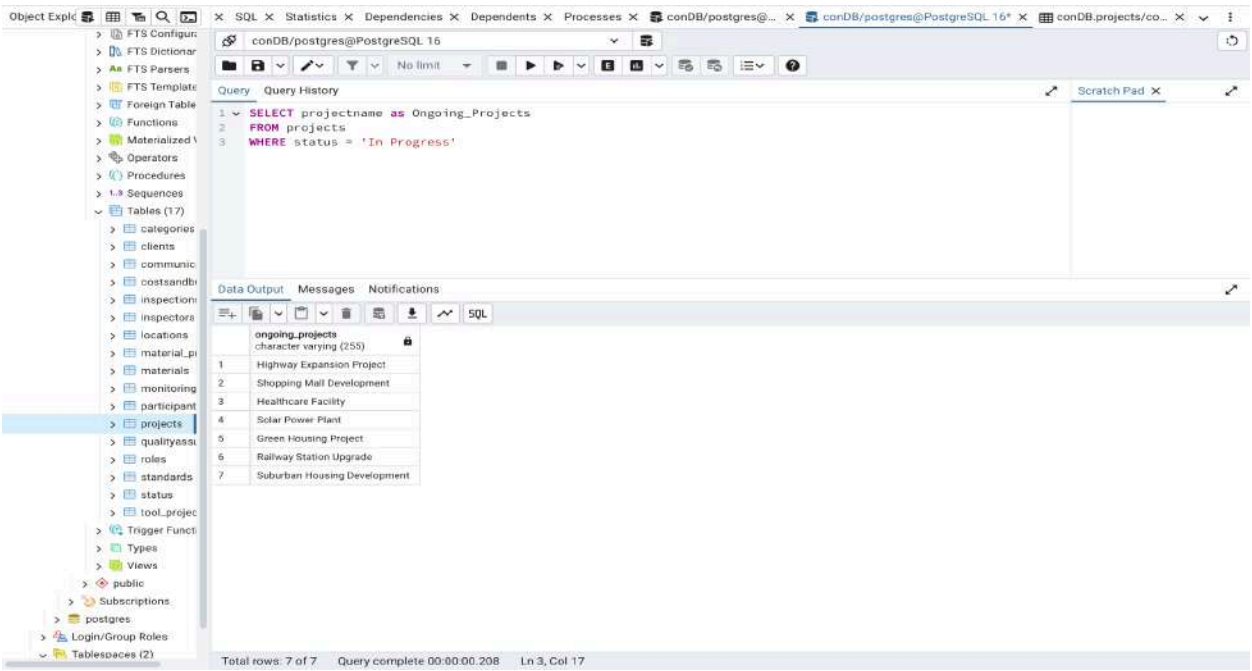
SQL Queries

1. Project with Maximum Participants

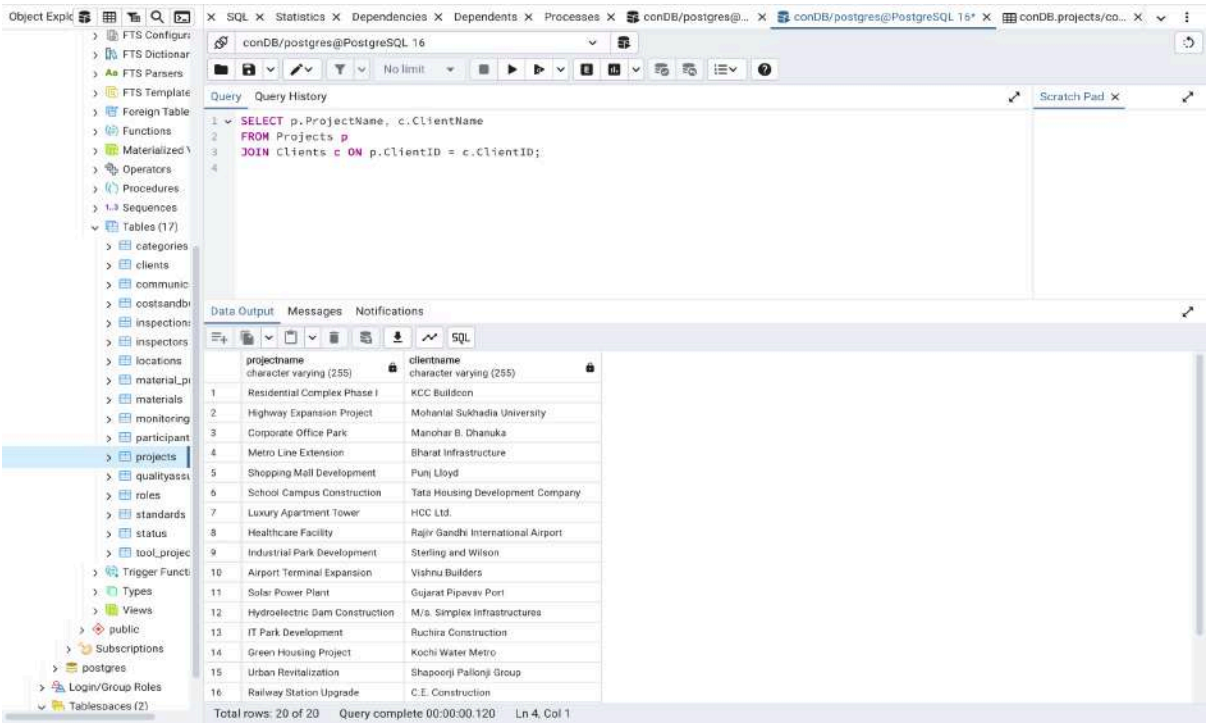


2. Projects with Least Participants

3. List all the Ongoing Projects



4. Retrieve All Projects with Their Clients' Names

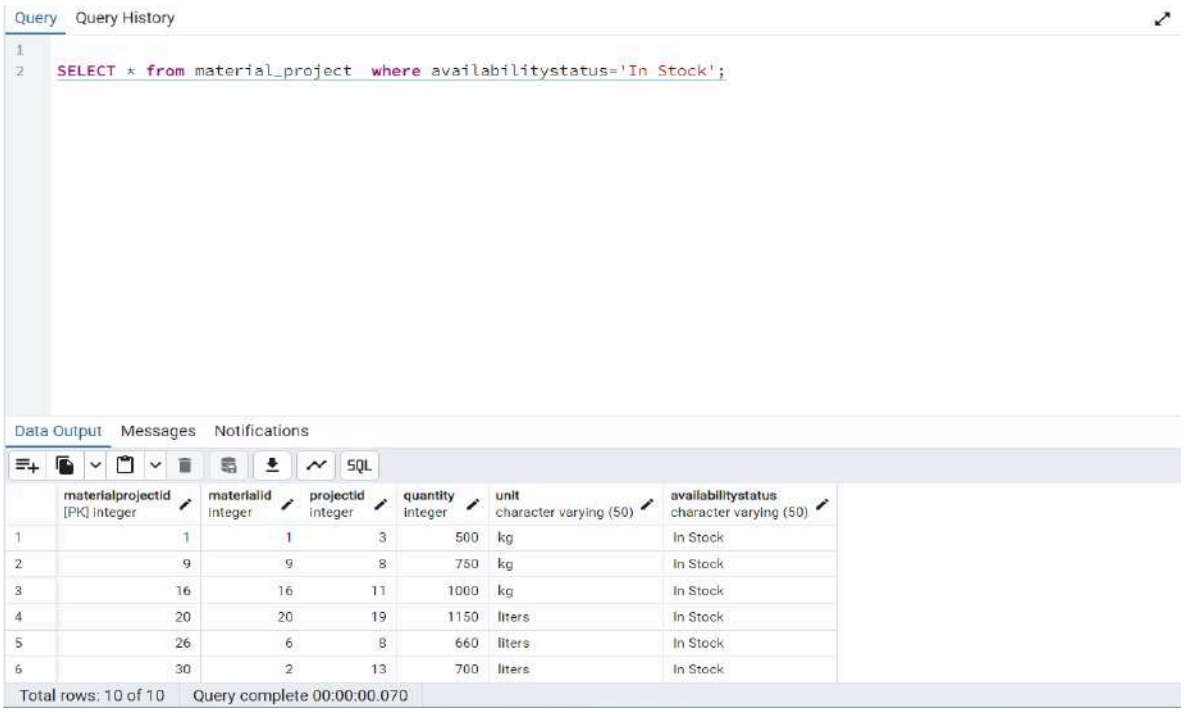


```
SELECT p.ProjectName, c.ClientName
FROM Projects p
JOIN Clients c ON p.ClientID = c.ClientID;
```

	projectname character varying (255)	clientname character varying (255)
1	Residential Complex Phase I	KCC Buildcon
2	Highway Expansion Project	Mohanlal Sukhadia University
3	Corporate Office Park	Manohar B. Dhanuka
4	Metro Line Extension	Bharat Infrastructure
5	Shopping Mall Development	Punj Lloyd
6	School Campus Construction	Tata Housing Development Company
7	Luxury Apartment Tower	HCC Ltd.
8	Healthcare Facility	Rajiv Gandhi International Airport
9	Industrial Park Development	Sterling and Wilson
10	Airport Terminal Expansion	Vishnu Builders
11	Solar Power Plant	Gujarat Pipavav Port
12	Hydroelectric Dam Construction	M/s. Simplex Infrastructures
13	IT Park Development	Ruchira Construction
14	Green Housing Project	Kochi Water Metro
15	Urban Revitalization	Shapoorji Pallonji Group
16	Railway Station Upgrade	C.E. Construction

Total rows: 20 of 20 Query complete 00:00:00.120 Ln 4, Col 1

5. Material which are currently in-stock

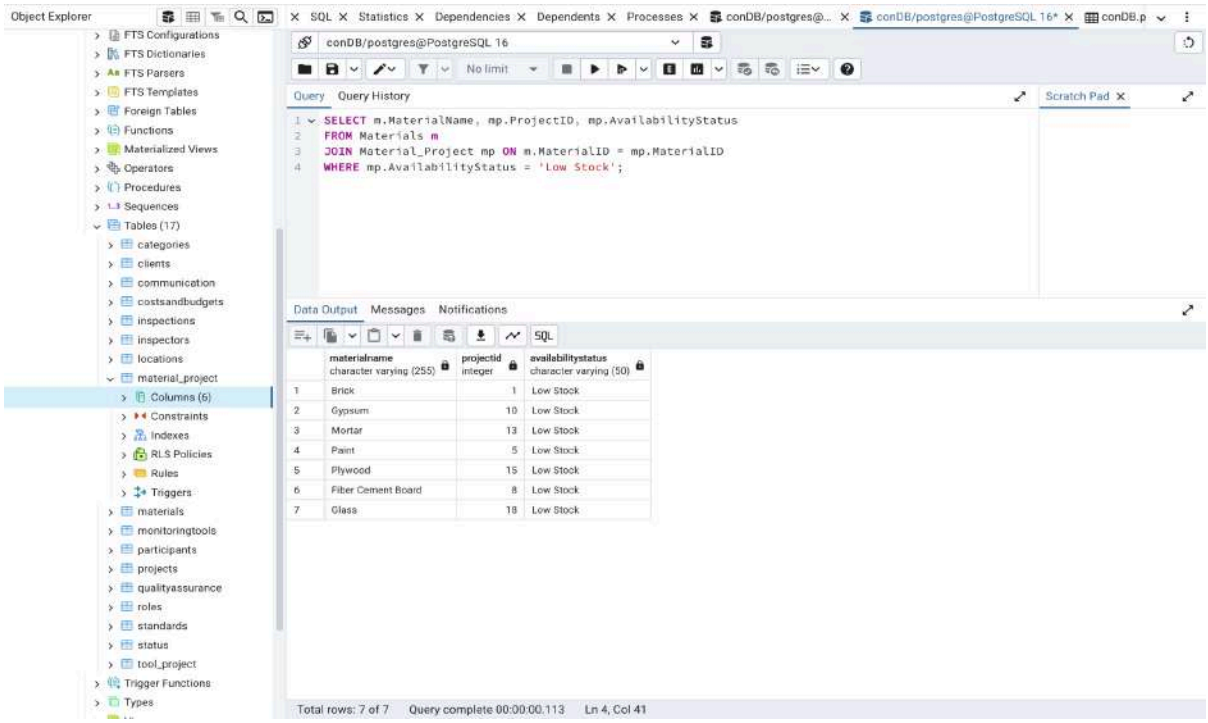


```
SELECT * from material_project  where availabilitystatus='In Stock';
```

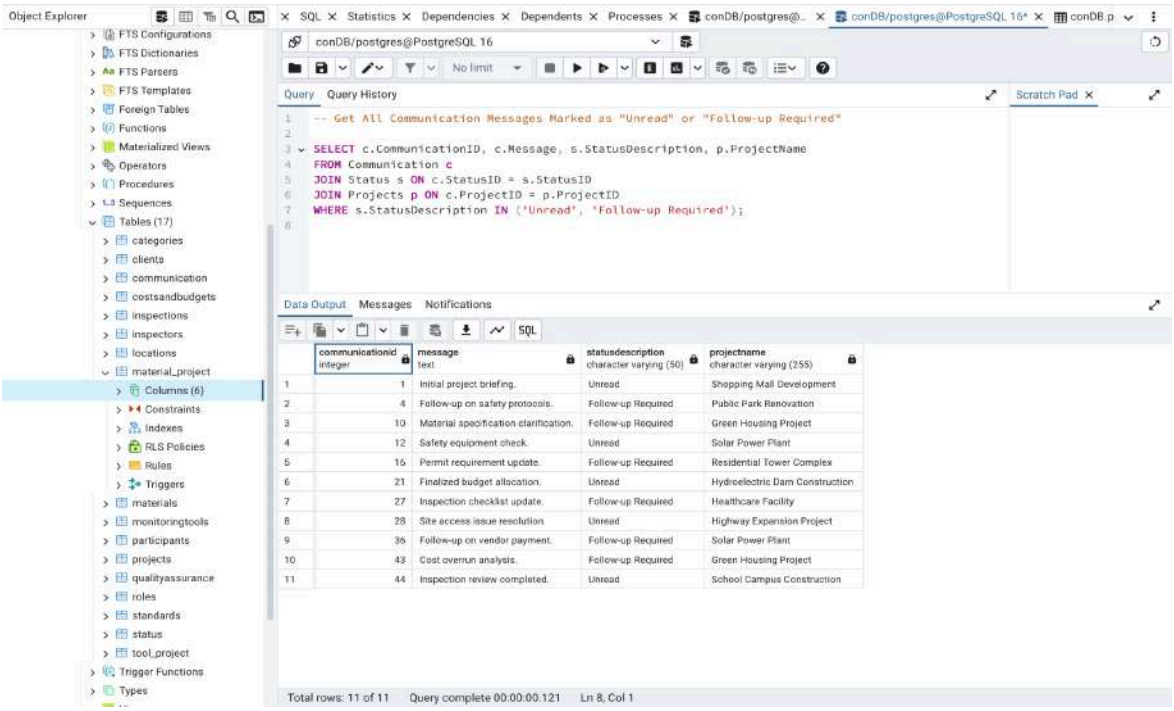
	materialprojectid [PK] integer	materialid integer	projectid integer	quantity integer	unit character varying (50)	availabilitystatus character varying (50)
1	1	1	3	500	kg	In Stock
2	9	9	8	750	kg	In Stock
3	16	16	11	1000	kg	In Stock
4	20	20	19	1150	liters	In Stock
5	26	6	8	660	liters	In Stock
6	30	2	13	700	liters	In Stock

Total rows: 10 of 10 Query complete 00:00:00.070

6. Show Materials That Have Low Availability in Projects



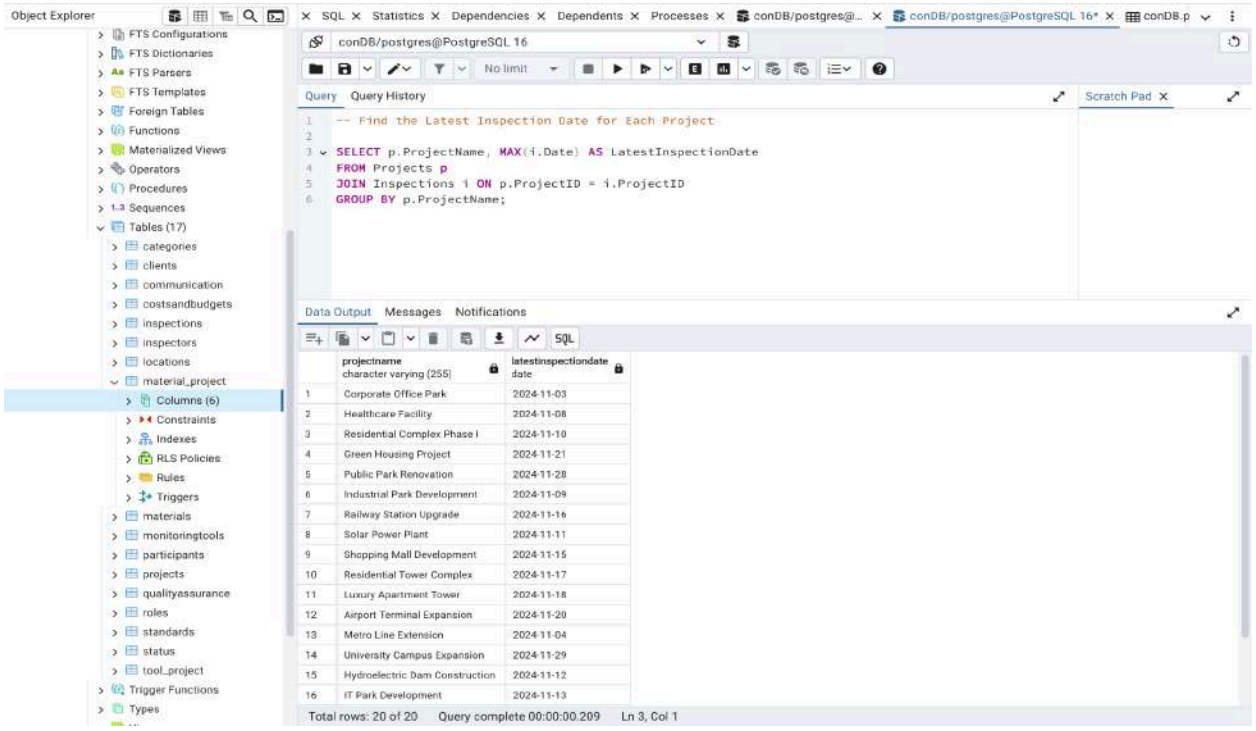
7. Get All Communication Messages Marked as "Unread" or "Follow-up Required"



```
-- Get All Communication Messages Marked as "Unread" or "Follow-up Required"

SELECT c.CommunicationID, c.Message, s.StatusDescription, p.ProjectName
FROM Communication c
JOIN Status s ON c.StatusID = s.StatusID
JOIN Projects p ON c.ProjectID = p.ProjectID
WHERE s.StatusDescription IN ('Unread', 'Follow-up Required');
```

communicationid integer	message text	statusdescription character varying (50)	projectname character varying (255)
1	Initial project briefing.	Unread	Shopping Mall Development
4	Follow-up on safety protocols.	Follow-up Required	Public Park Renovation
10	Material specification clarification.	Follow-up Required	Green Housing Project
12	Safety equipment check.	Unread	Solar Power Plant
16	Permit requirement update.	Follow-up Required	Residential Tower Complex
21	Finalized budget allocation.	Unread	Hydroelectric Dam Construction
27	Inspection checklist update.	Follow-up Required	Healthcare Facility
28	Site access issue resolution.	Unread	Highway Expansion Project
36	Follow-up on vendor payment.	Follow-up Required	Solar Power Plant
43	Cost overrun analysis.	Follow-up Required	Green Housing Project
44	Inspection review completed.	Unread	School Campus Construction

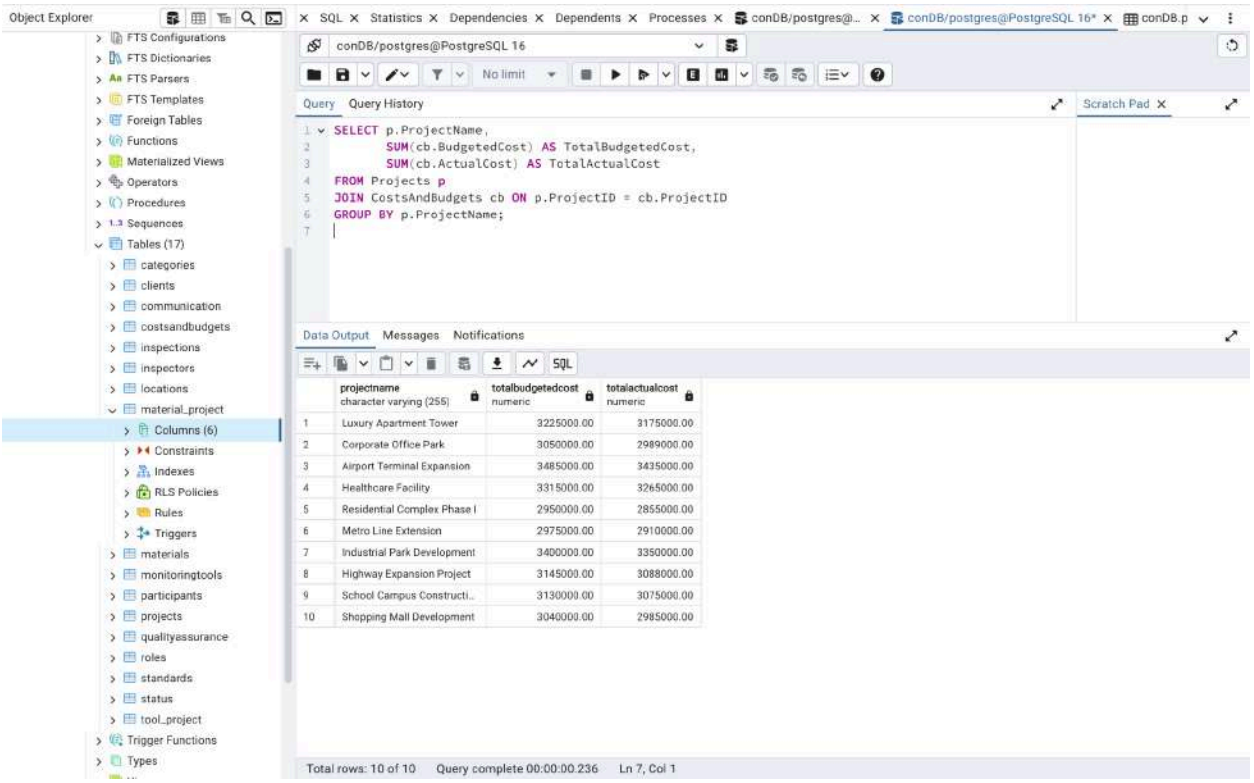
8. Find the Latest Inspection Date for Each Project



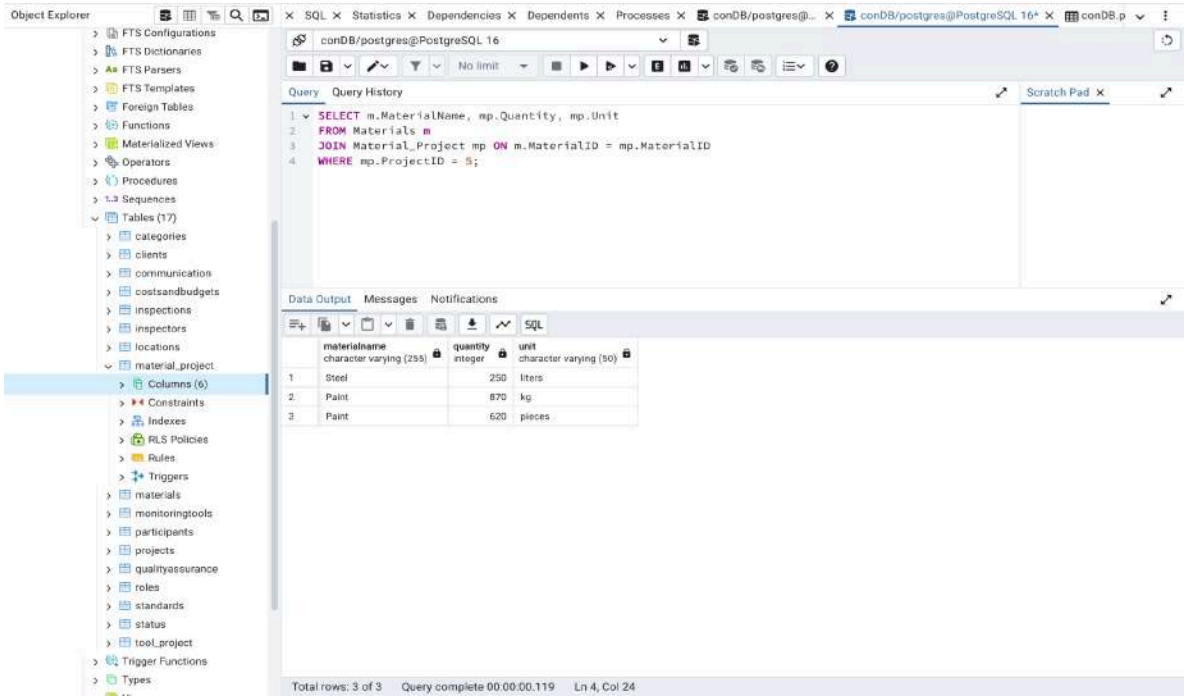
```
-- Find the Latest Inspection Date for Each Project

SELECT p.ProjectName, MAX(i.Date) AS LatestInspectionDate
FROM Projects p
JOIN Inspections i ON p.ProjectID = i.ProjectID
GROUP BY p.ProjectName;
```

projectname character varying (255)	latestinspectiondate date
Corporate Office Park	2024-11-03
Healthcare Facility	2024-11-08
Residential Complex Phase I	2024-11-10
Green Housing Project	2024-11-21
Public Park Renovation	2024-11-28
Industrial Park Development	2024-11-09
Railway Station Upgrade	2024-11-16
Solar Power Plant	2024-11-11
Shopping Mall Development	2024-11-15
Residential Tower Complex	2024-11-17
Luxury Apartment Tower	2024-11-18
Airport Terminal Expansion	2024-11-20
Metro Line Extension	2024-11-04
University Campus Expansion	2024-11-29
Hydroelectric Dam Construction	2024-11-12
IT Park Development	2024-11-13

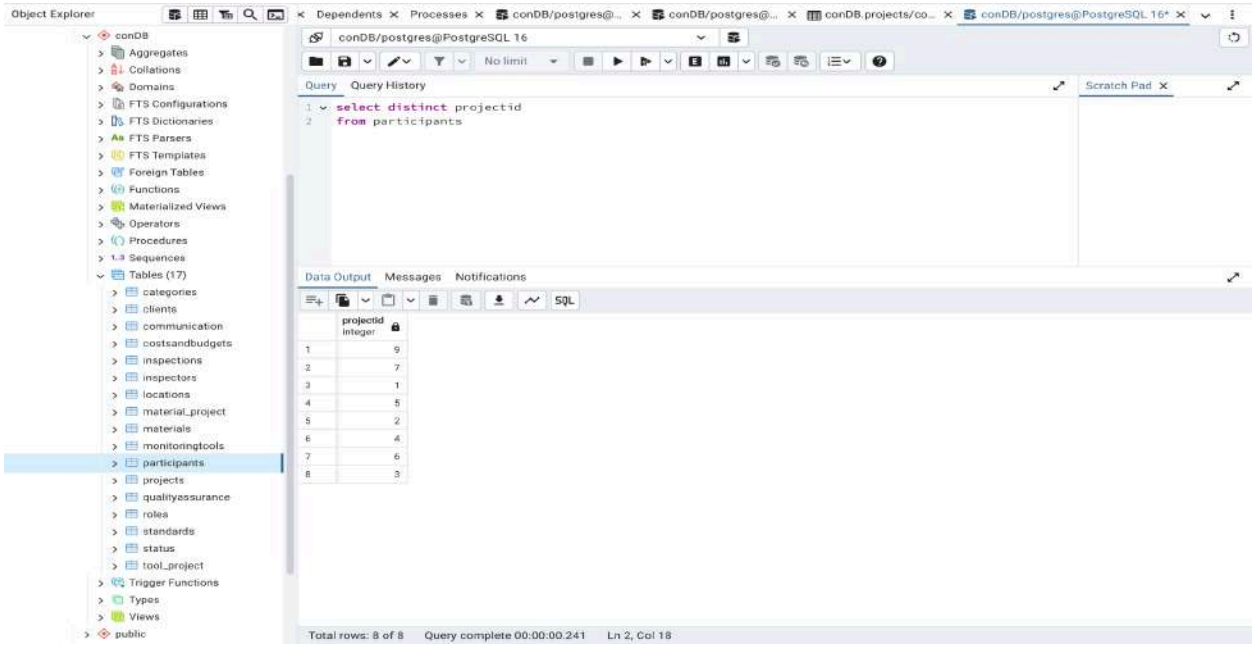
9. Find the Total Budgeted and Actual Costs for Each Project



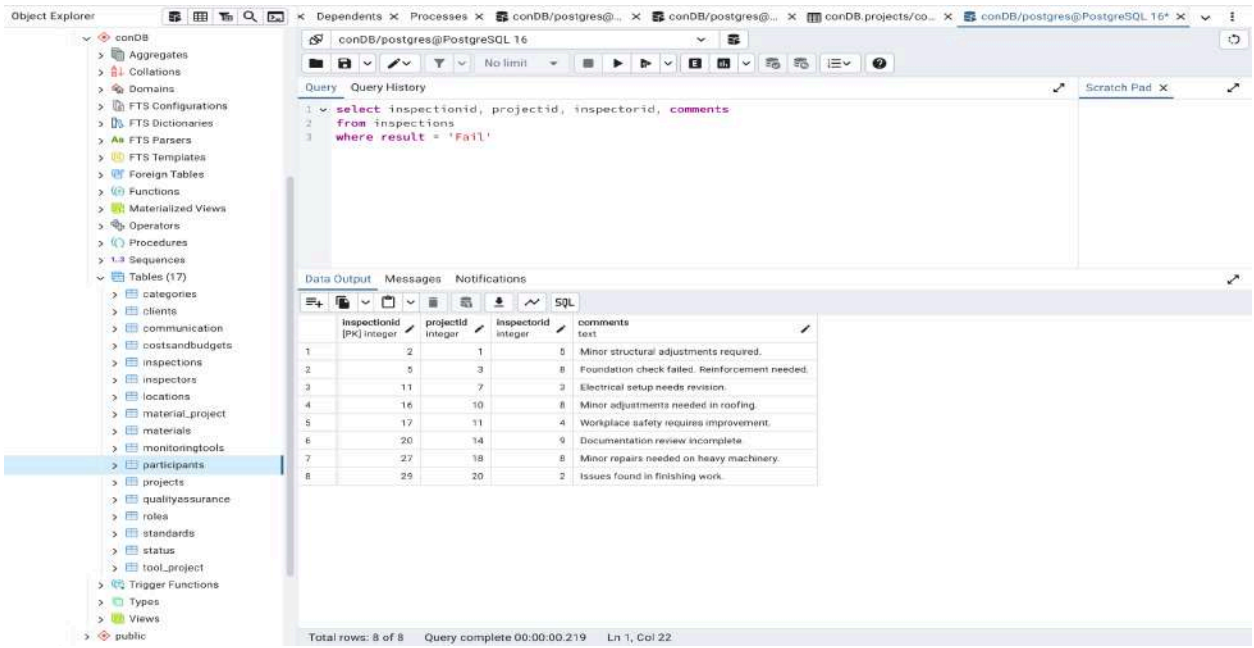
10. Get a List of All Materials Used in a Specific Project (e.g., ProjectID = 5)



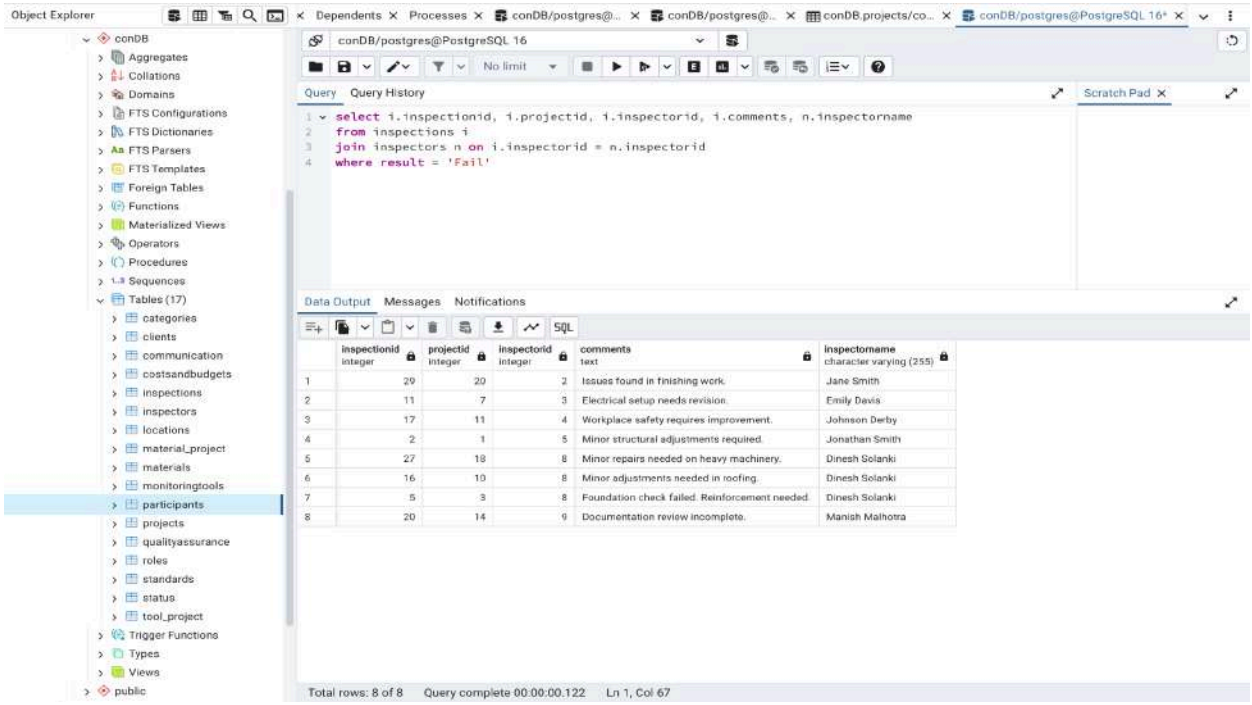
11. Find out which projects have participants assigned without including each individual participant



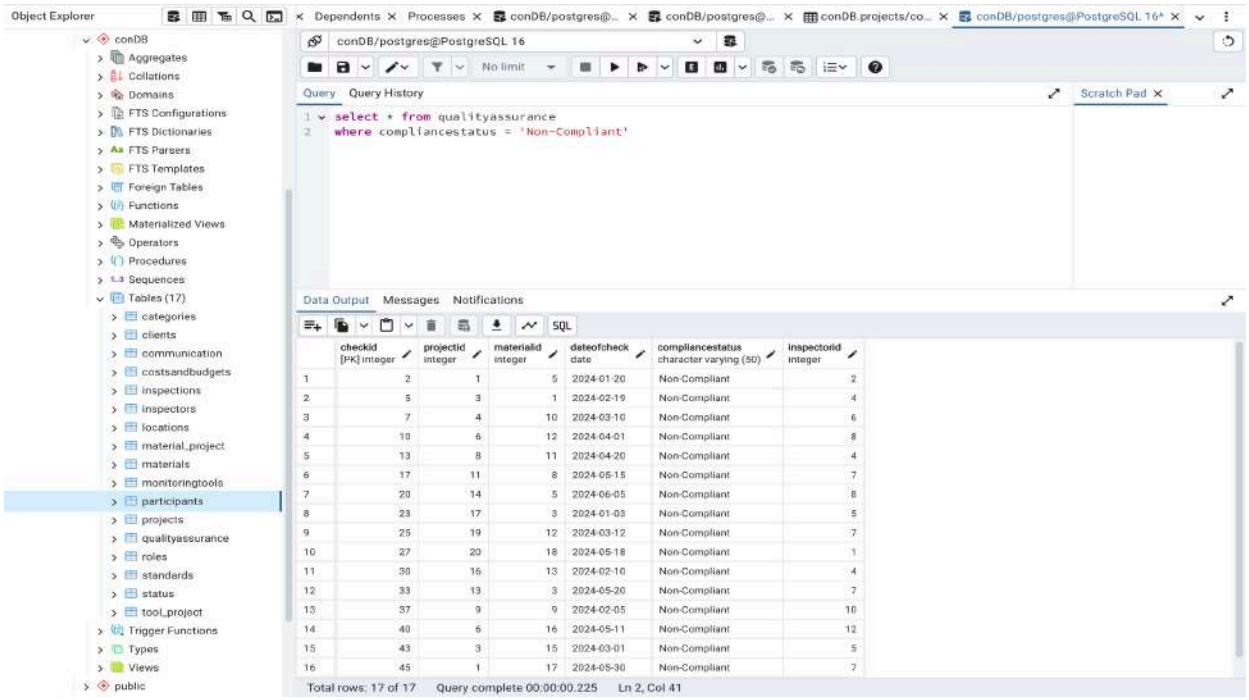
12. Find the details of the inspections where the result of the inspection is Fail



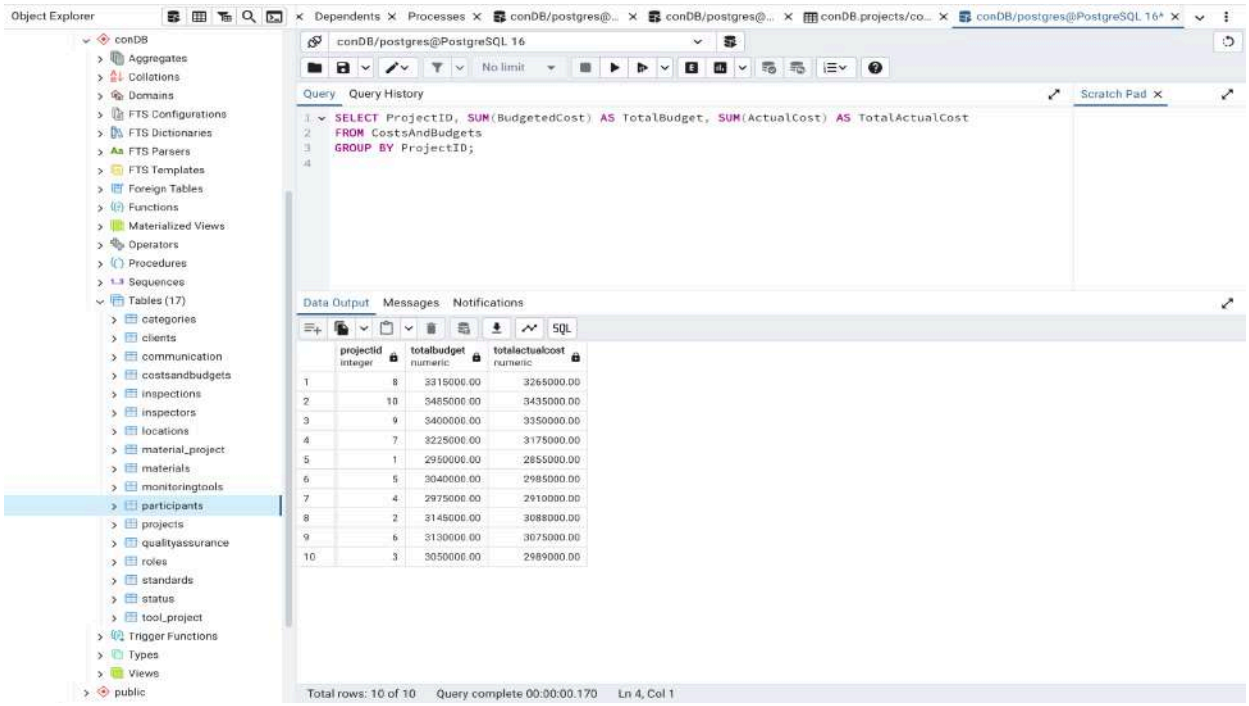
13. Get the name of the Inspector for further inspection where the result of the inspection is Fail



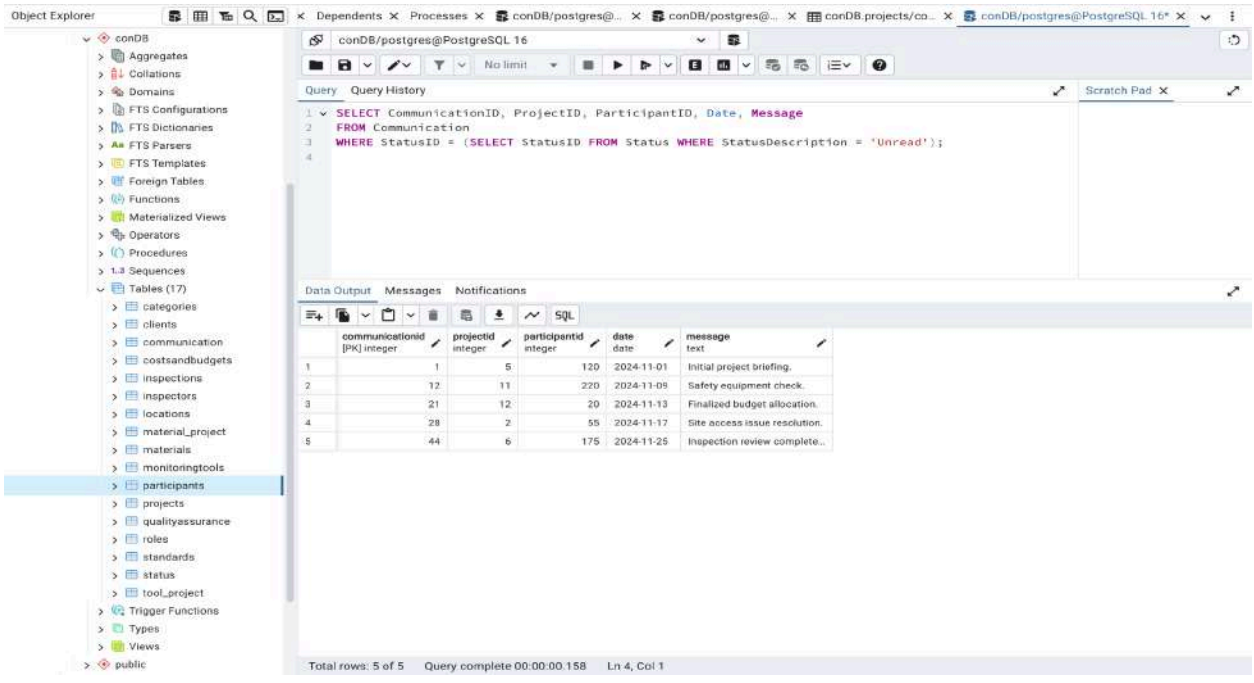
14. List the quality assurances where the compliance status is Non-Compliant



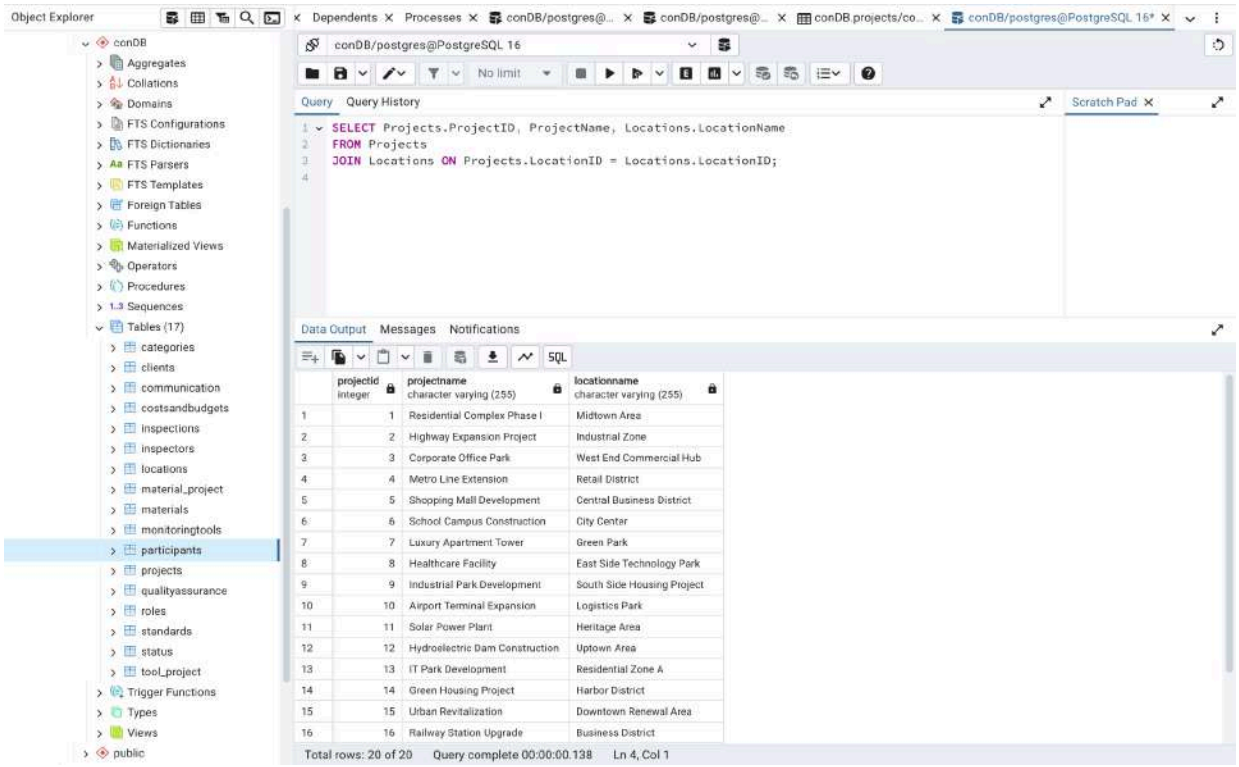
15. List the total budget and actual cost for each project.



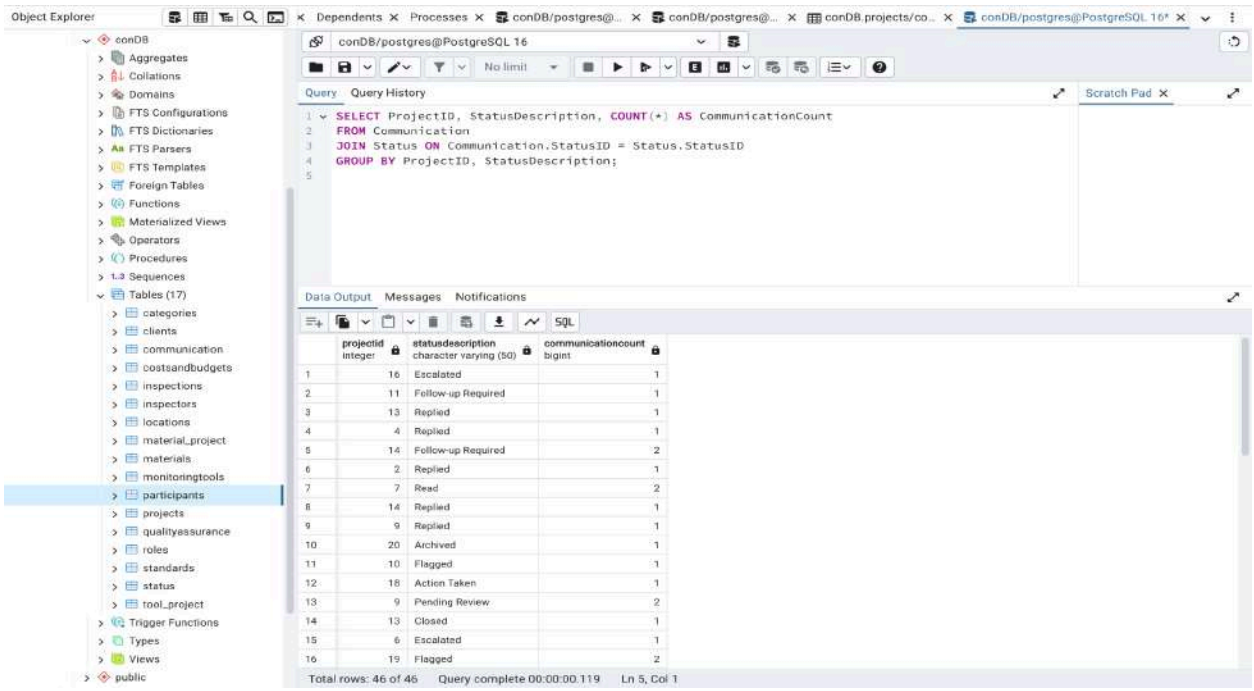
16. Find all communications marked as 'Unread'



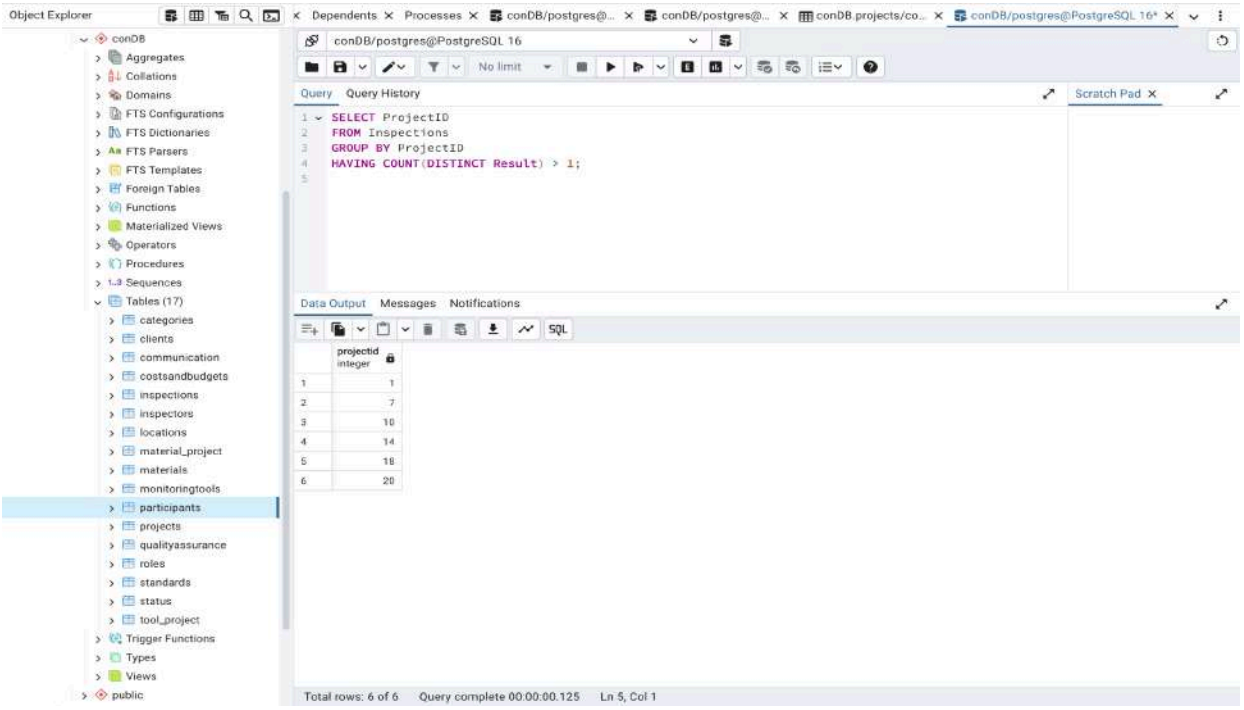
17. List projects along with their locations



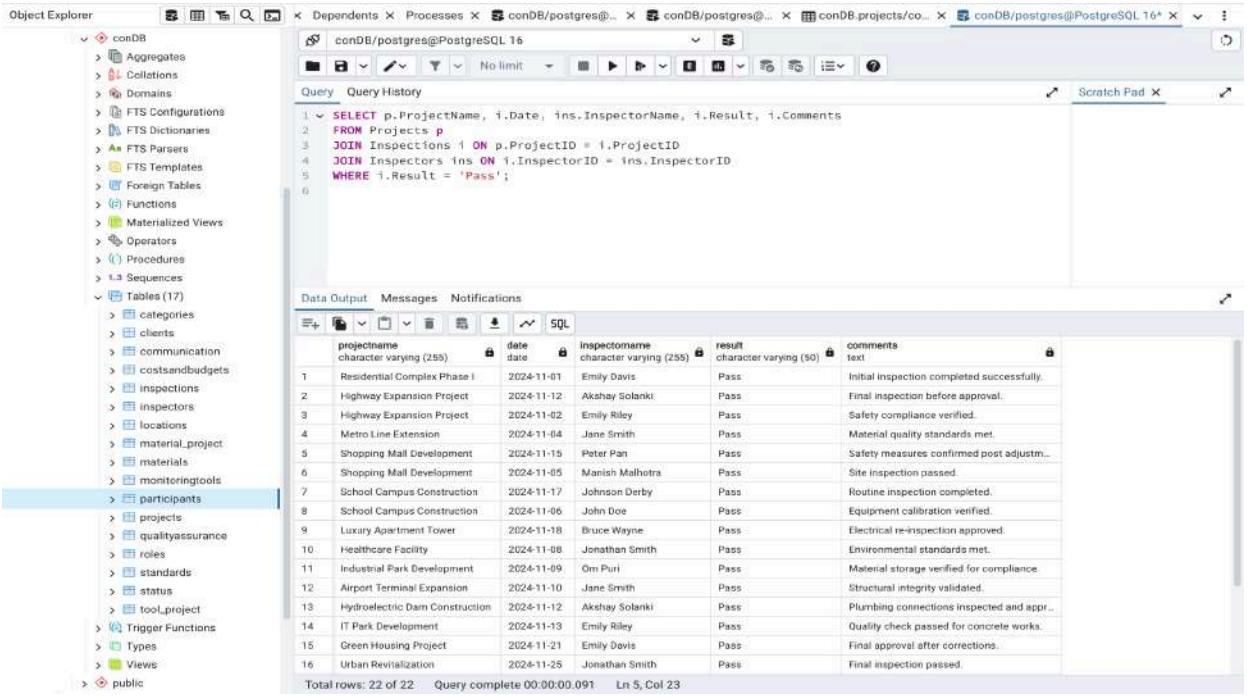
18. Get the count of communications by status for each project.



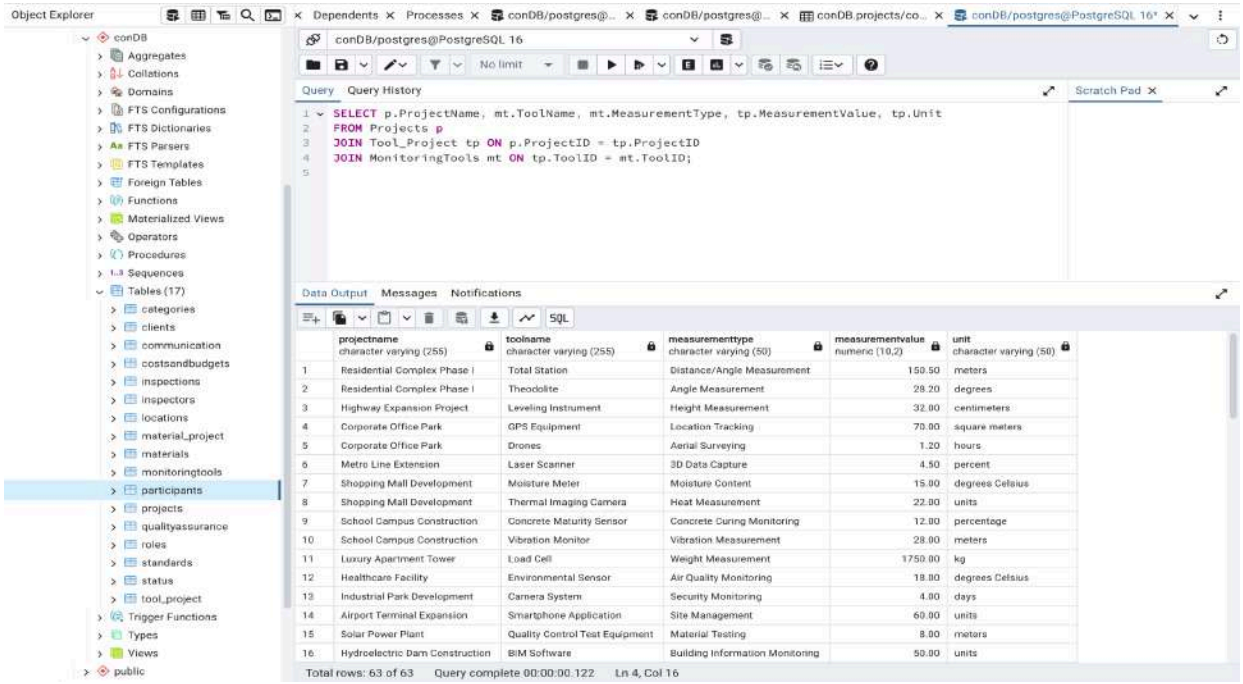
19. List projects where inspections resulted in more than one type of outcome.



20. List All Projects with Completed Inspections and Their Results



21. List Monitoring Tools Used in Each Project with Measurement Type

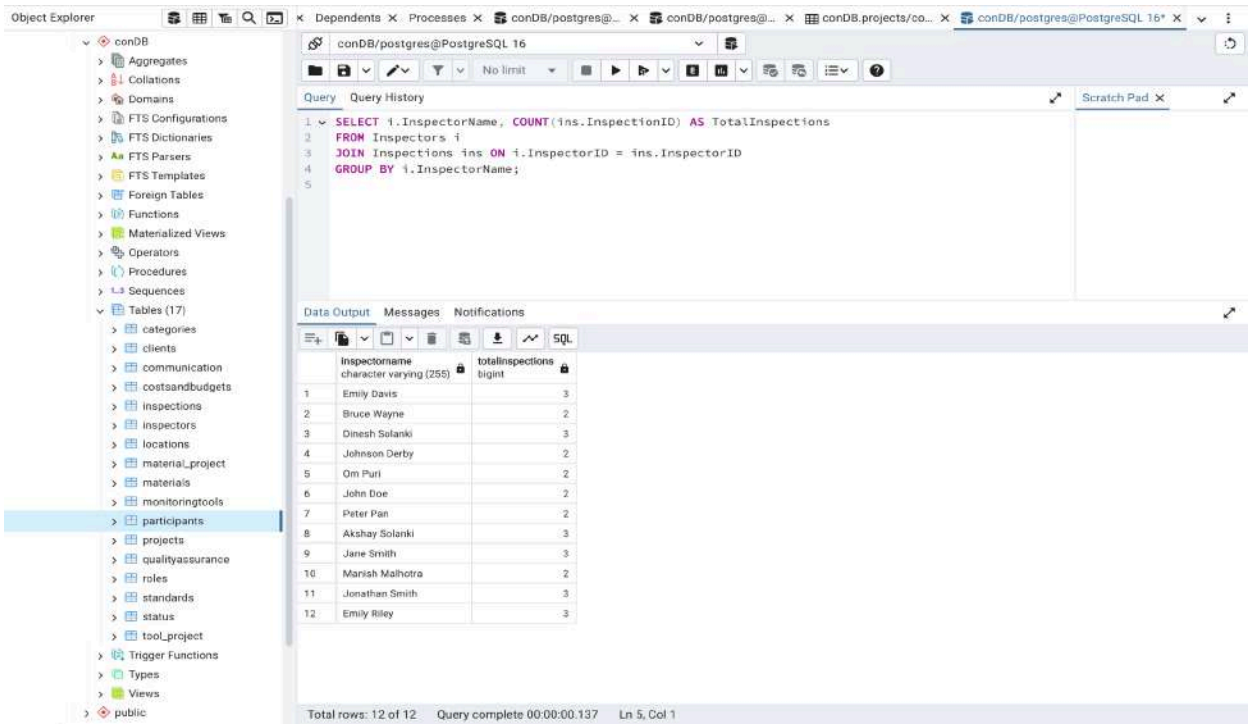


```
SELECT p.ProjectName, mt.ToolName, mt.MeasurementType, tp.MeasurementValue, tp.Unit
FROM Projects p
JOIN Tool_Project tp ON p.ProjectID = tp.ProjectID
JOIN MonitoringTools mt ON tp.ToolID = mt.ToolID;
```

	projectname character varying (255)	toolname character varying (255)	measurementtype character varying (50)	measurementvalue numeric (10,2)	unit character varying (50)
1	Residential Complex Phase I	Total Station	Distance/Angle Measurement	150.50	meters
2	Residential Complex Phase I	Theodolite	Angle Measurement	28.20	degrees
3	Highway Expansion Project	Leveling Instrument	Height Measurement	32.00	centimeters
4	Corporate Office Park	GPS Equipment	Location Tracking	70.00	square meters
5	Corporate Office Park	Drones	Aerial Surveying	1.20	hours
6	Metro Line Extension	Laser Scanner	3D Data Capture	4.50	percent
7	Shopping Mall Development	Moisture Meter	Moisture Content	15.00	degrees Celsius
8	Shopping Mall Development	Thermal Imaging Camera	Heat Measurement	22.00	units
9	School Campus Construction	Concrete Maturity Sensor	Concrete Curing Monitoring	12.00	percentage
10	School Campus Construction	Vibration Monitor	Vibration Measurement	28.00	meters
11	Luxury Apartment Tower	Load Cell	Weight Measurement	1750.00	kg
12	Healthcare Facility	Environmental Sensor	Air Quality Monitoring	18.00	degrees Celsius
13	Industrial Park Development	Camera System	Security Monitoring	4.00	days
14	Airport Terminal Expansion	Smartphone Application	Site Management	60.00	units
15	Solar Power Plant	Quality Control Test Equipment	Material Testing	8.00	meters
16	Hydroelectric Dam Construction	BIM Software	Building Information Monitoring	50.00	units

Total rows: 63 of 63 Query complete 00:00:00.122 Ln 4, Col 16

22. Find Inspectors and Number of Inspections They Conducted

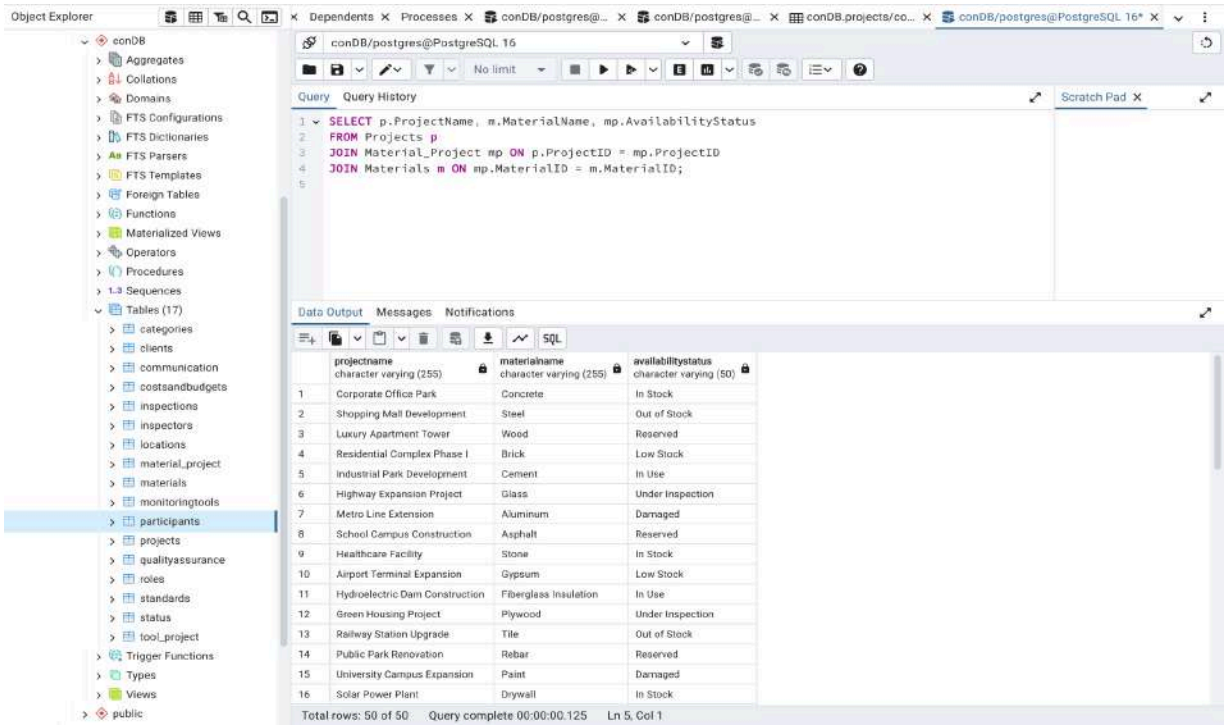


```
SELECT i.InspectorName, COUNT(ins.InspectionID) AS TotalInspections
FROM Inspectors i
JOIN Inspections ins ON i.InspectorID = ins.InspectorID
GROUP BY i.InspectorName;
```

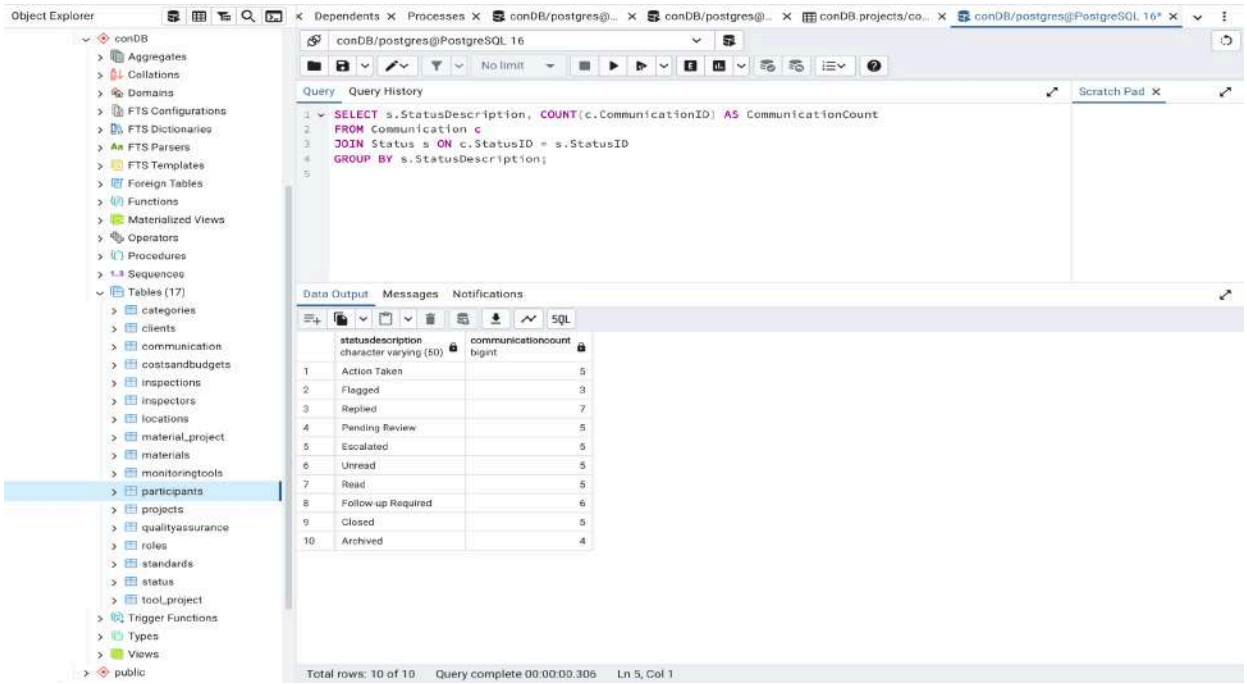
	inspectorname character varying (255)	totalinspections bigint
1	Emily Davis	3
2	Bruce Wayne	2
3	Dinesh Solanki	3
4	Johnson Derby	2
5	Om Puri	2
6	John Doe	2
7	Peter Pan	2
8	Akshay Solanki	3
9	Jane Smith	3
10	Manish Malhotra	2
11	Jonathan Smith	3
12	Emily Riley	3

Total rows: 12 of 12 Query complete 00:00:00.137 Ln 5, Col 1

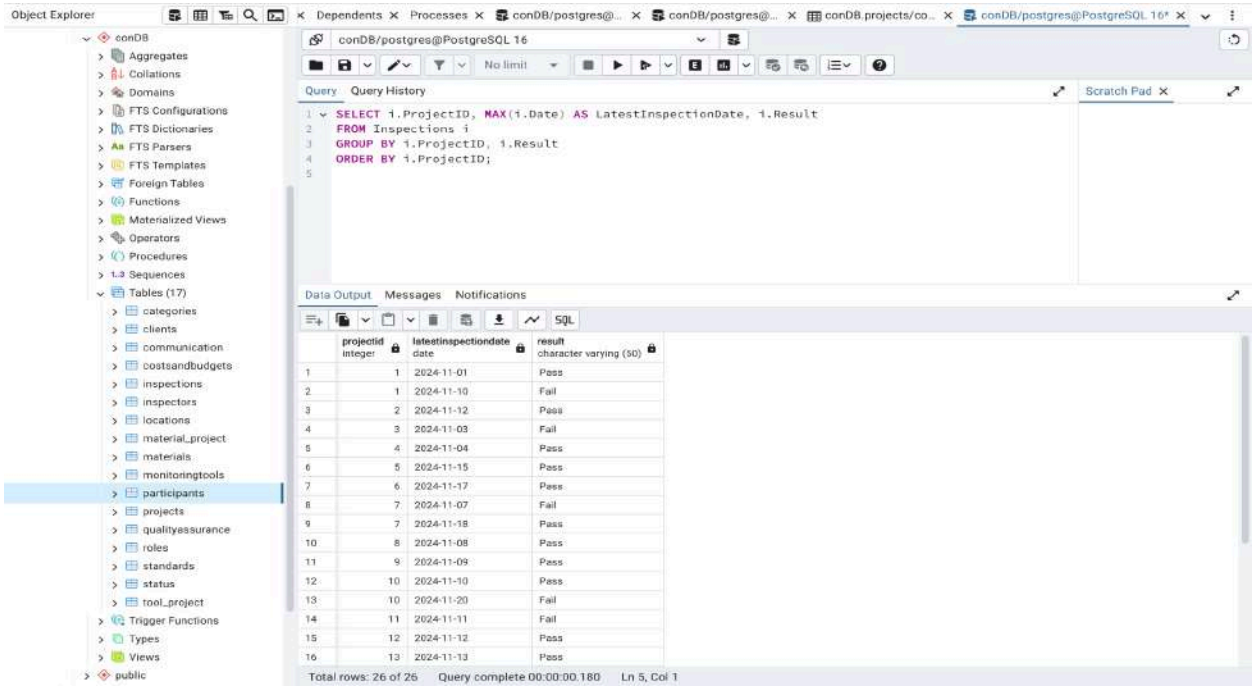
23. Display Materials Availability Status for Each Project



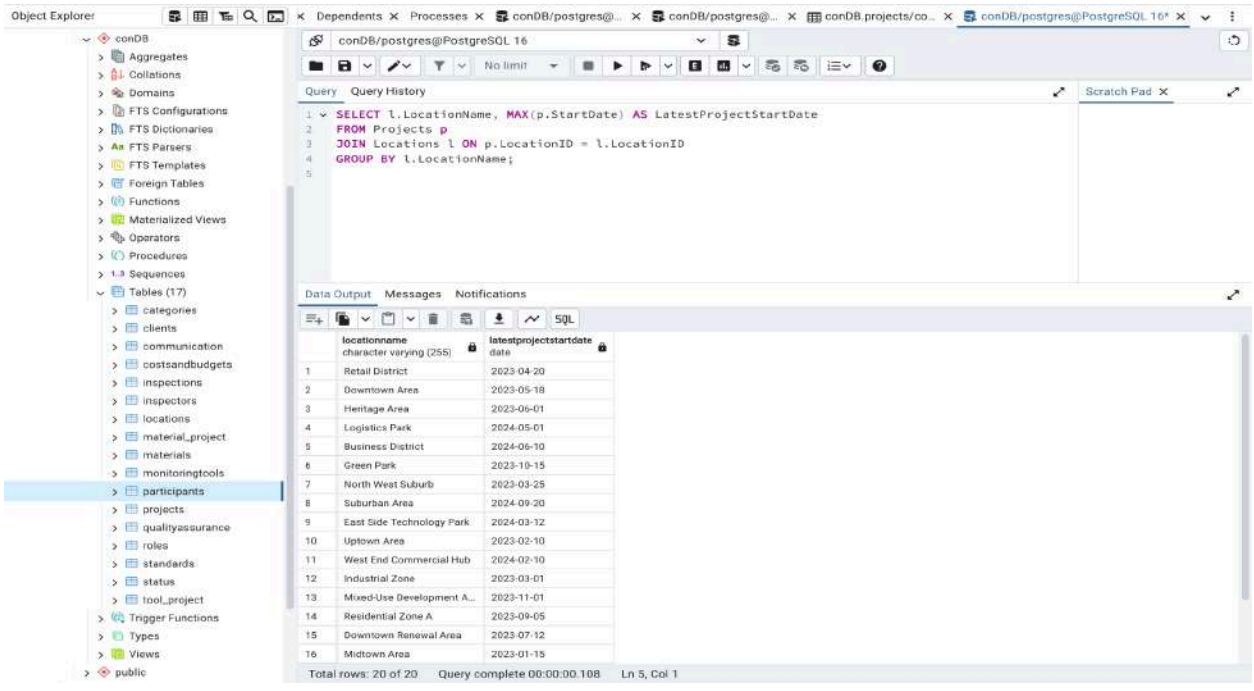
24. Retrieve the number of communications with each unique status across all projects:



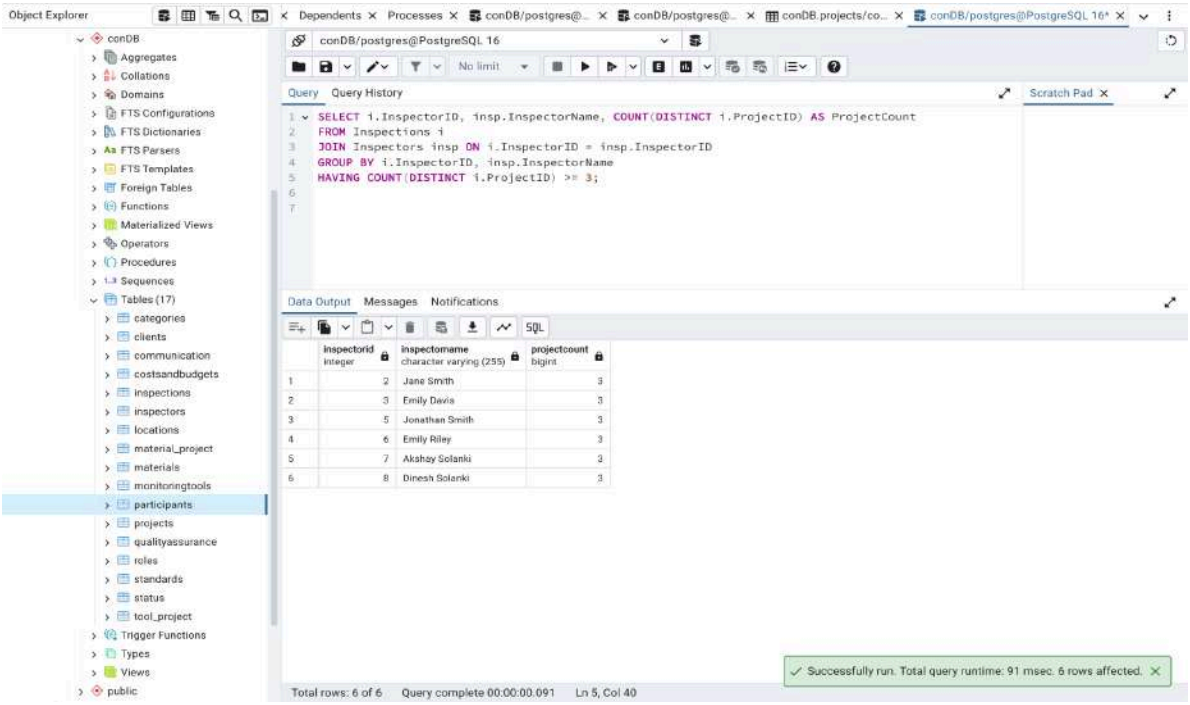
25. List the latest inspection date for each project and the result of that inspection.



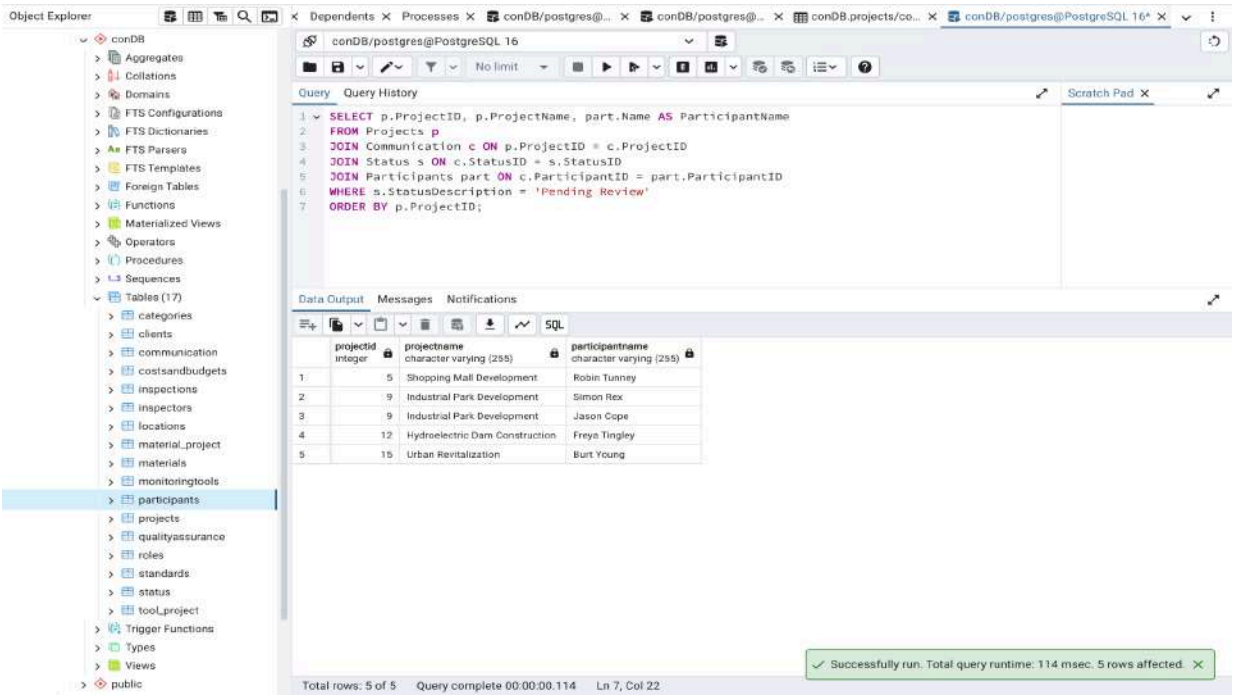
26. Find the latest start date of any project within each location.



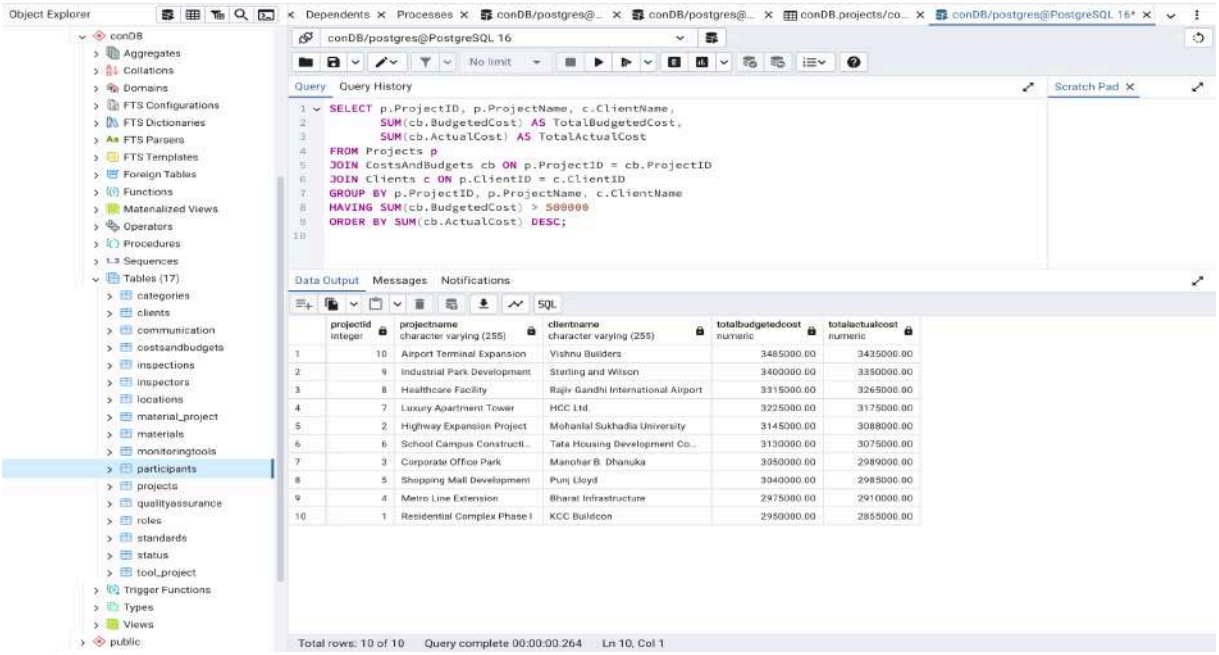
27. List inspectors who have performed inspections on at least 3 different projects:



28. List projects and their participants who have pending communication:



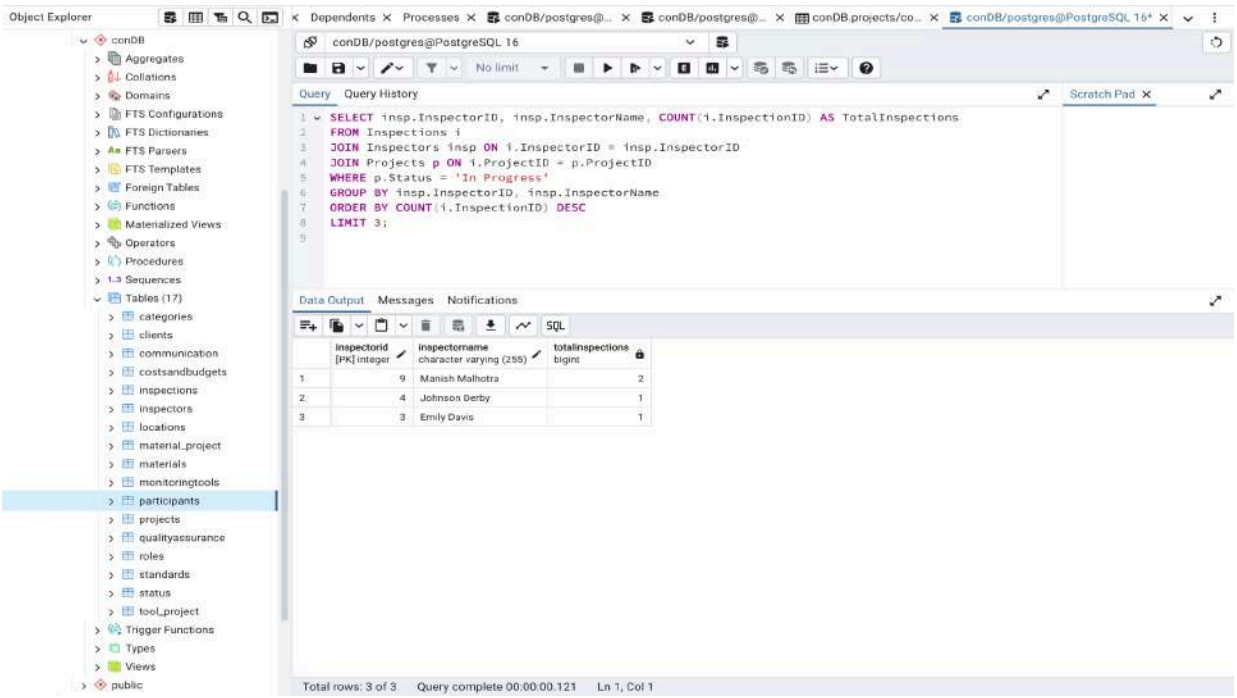
29. Identify projects with the highest material costs, including both budgeted and actual costs, and categorize them by client.



```
SELECT p.ProjectID, p.ProjectName, c.ClientName,
       SUM(cb.BudgetedCost) AS TotalBudgetedCost,
       SUM(cb.ActualCost) AS TotalActualCost
FROM Projects p
JOIN CostsAndBudgets cb ON p.ProjectID = cb.ProjectID
JOIN Clients c ON p.ClientID = c.ClientID
GROUP BY p.ProjectID, p.ProjectName, c.ClientName
HAVING SUM(cb.BudgetedCost) > 500000
ORDER BY SUM(cb.ActualCost) DESC;
```

projectid integer	projectname character varying (255)	clientname character varying (255)	totalbudgetedcost numeric	totalactualcost numeric
10	Airport Terminal Expansion	Vishnu Builders	3485000.00	3435000.00
9	Industrial Park Development	Sterling and Wilson	3400000.00	3350000.00
8	Healthcare Facility	Rajiv Gandhi International Airport	3315000.00	3265000.00
7	Luxury Apartment Tower	HCC Ltd.	3225000.00	3175000.00
2	Highway Expansion Project	Mohanlal Sukhadia University	3145000.00	3088000.00
6	School Campus Constructi...	Tata Housing Development Co...	3130000.00	3075000.00
3	Corporate Office Park	Manohar B. Dhanuka	3050000.00	2989000.00
5	Shopping Mall Development	Punj Lloyd	3040000.00	2985000.00
4	Metro Line Extension	Bharat Infrastructure	2975000.00	2910000.00
1	Residential Complex Phase I	KCC Buildcon	2950000.00	2855000.00

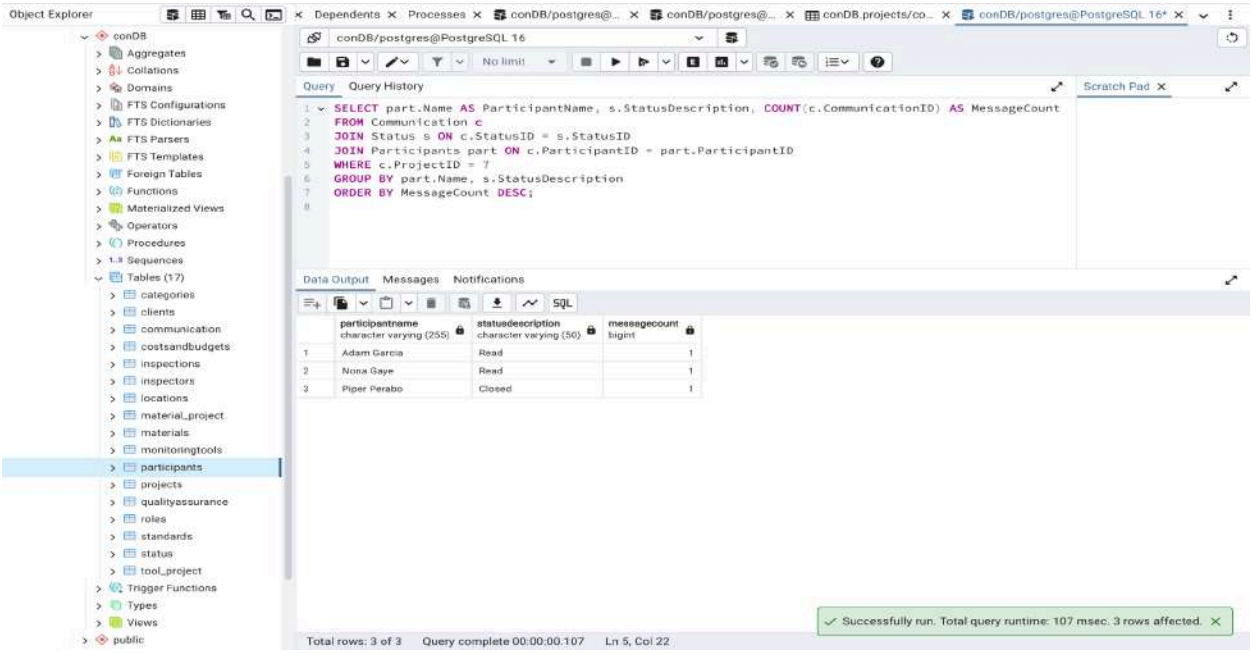
30. Find the top 3 inspectors with the most inspections on projects that are currently "In Progress".



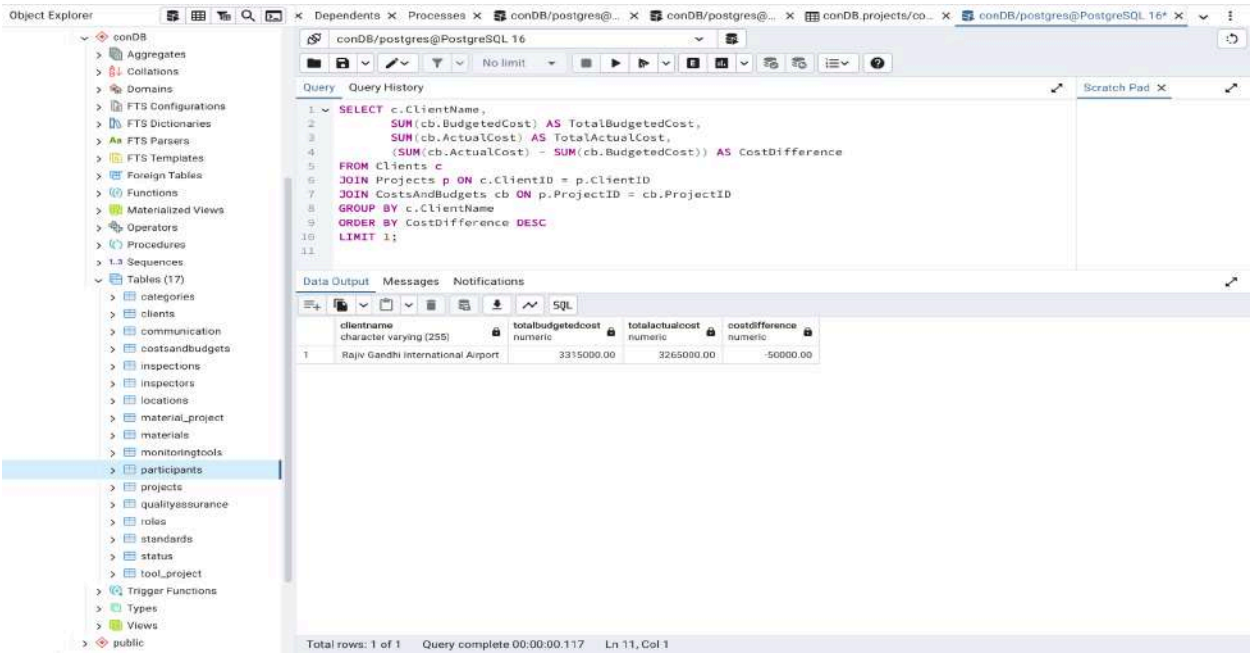
```
SELECT insp.InspectorID, insp.InspectorName, COUNT(i.InspectionID) AS TotalInspections
FROM Inspections i
JOIN Inspectors insp ON i.InspectorID = insp.InspectorID
JOIN Projects p ON i.ProjectID = p.ProjectID
WHERE p.Status = 'In Progress'
GROUP BY insp.InspectorID, insp.InspectorName
ORDER BY COUNT(i.InspectionID) DESC
LIMIT 3;
```

inspectorid [PK] integer	inspectorname character varying (255)	totalinspections bigint
9	Manish Malhotra	2
4	Johnson Derby	1
3	Emily Davis	1

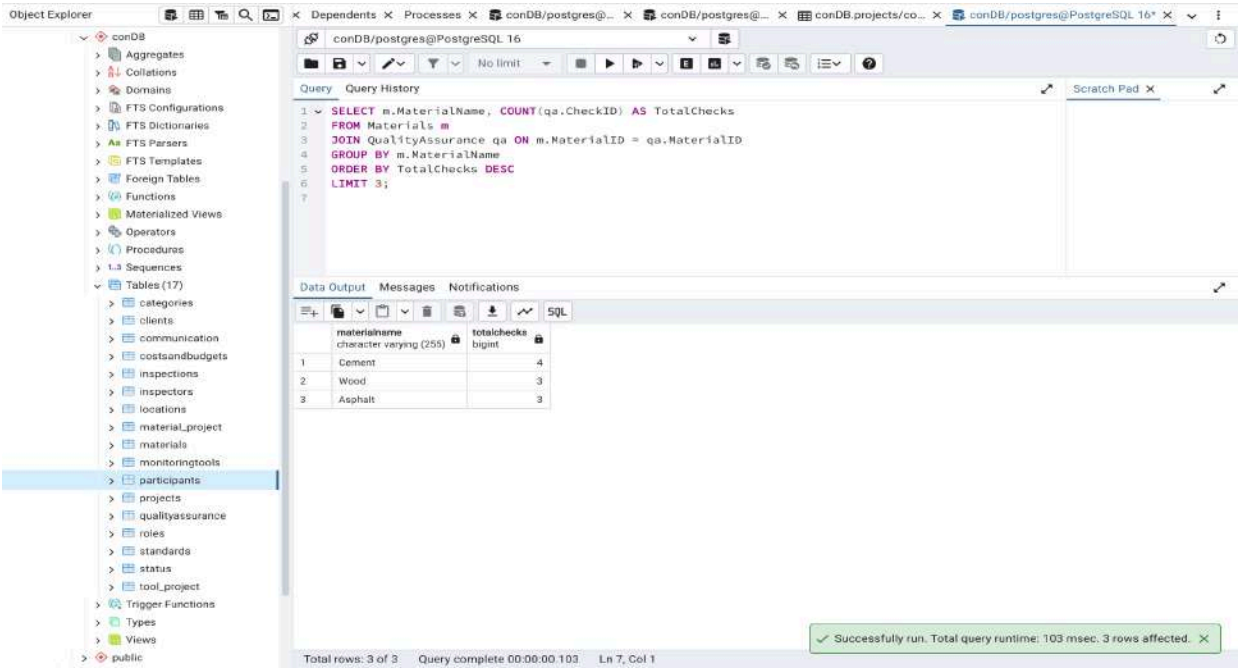
31. Get the communication status and total count of replies for each participant in a specific project.



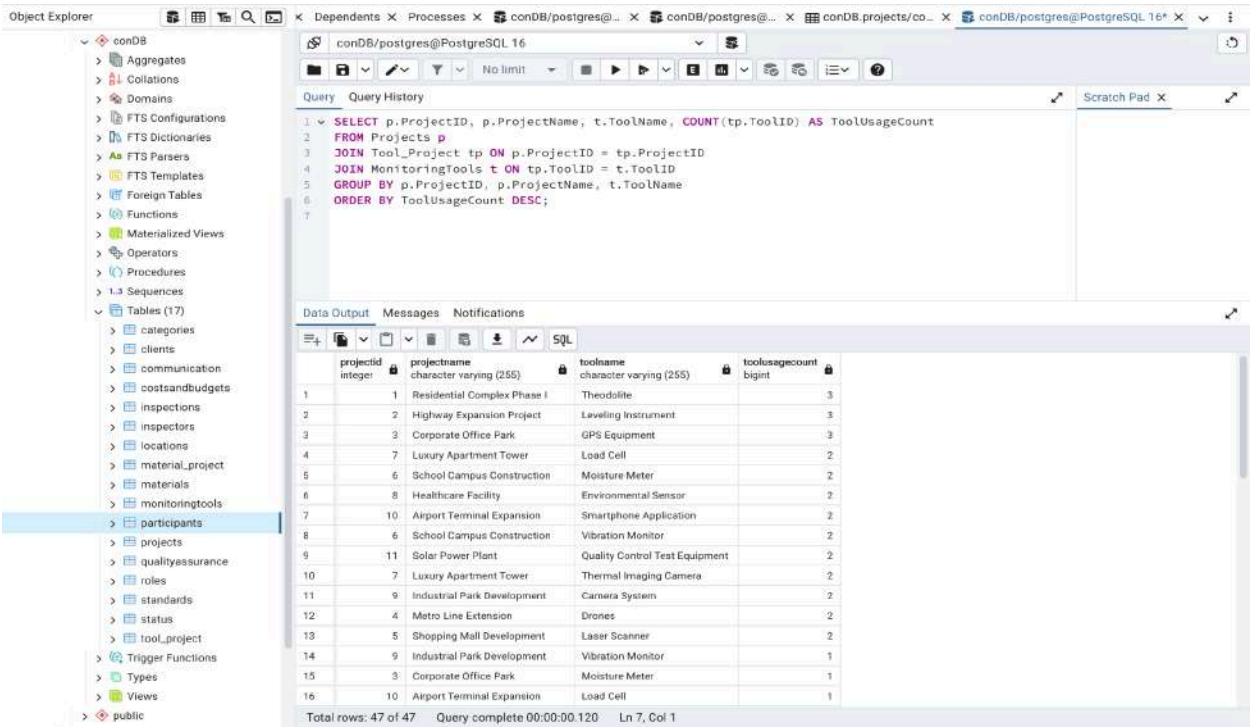
32. Find the total budgeted and actual costs for all projects, grouped by client, and identify the client with the largest cost difference.



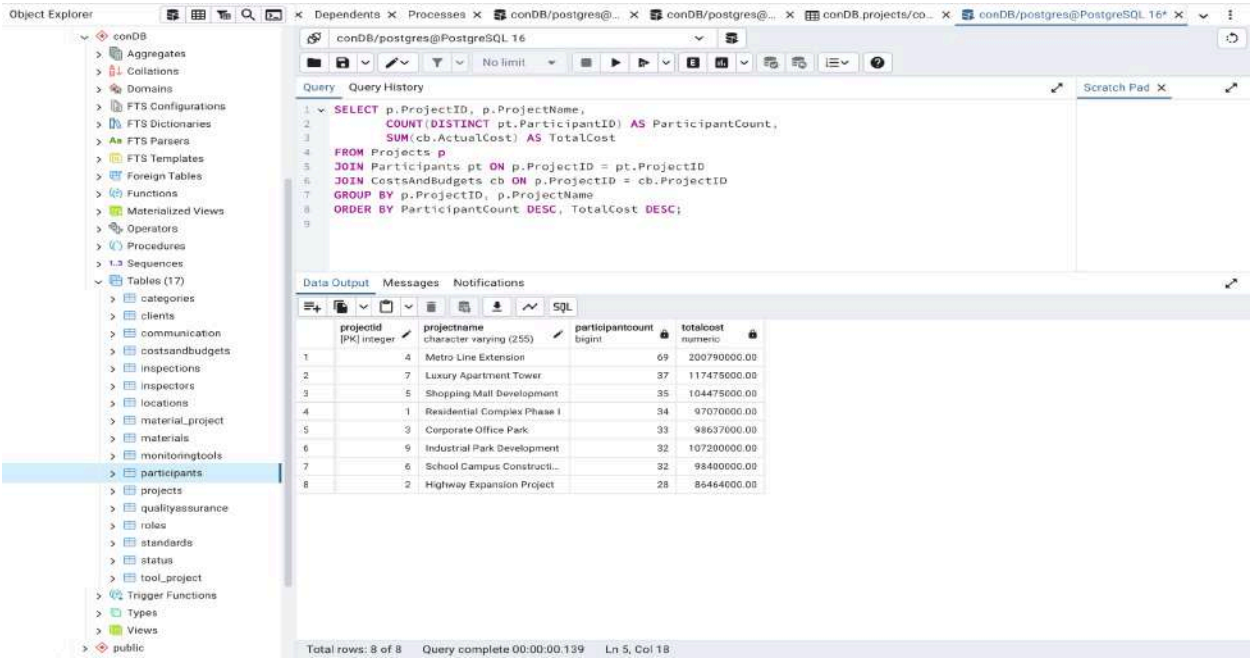
33. Find the top 3 materials with the highest number of quality checks across all projects.



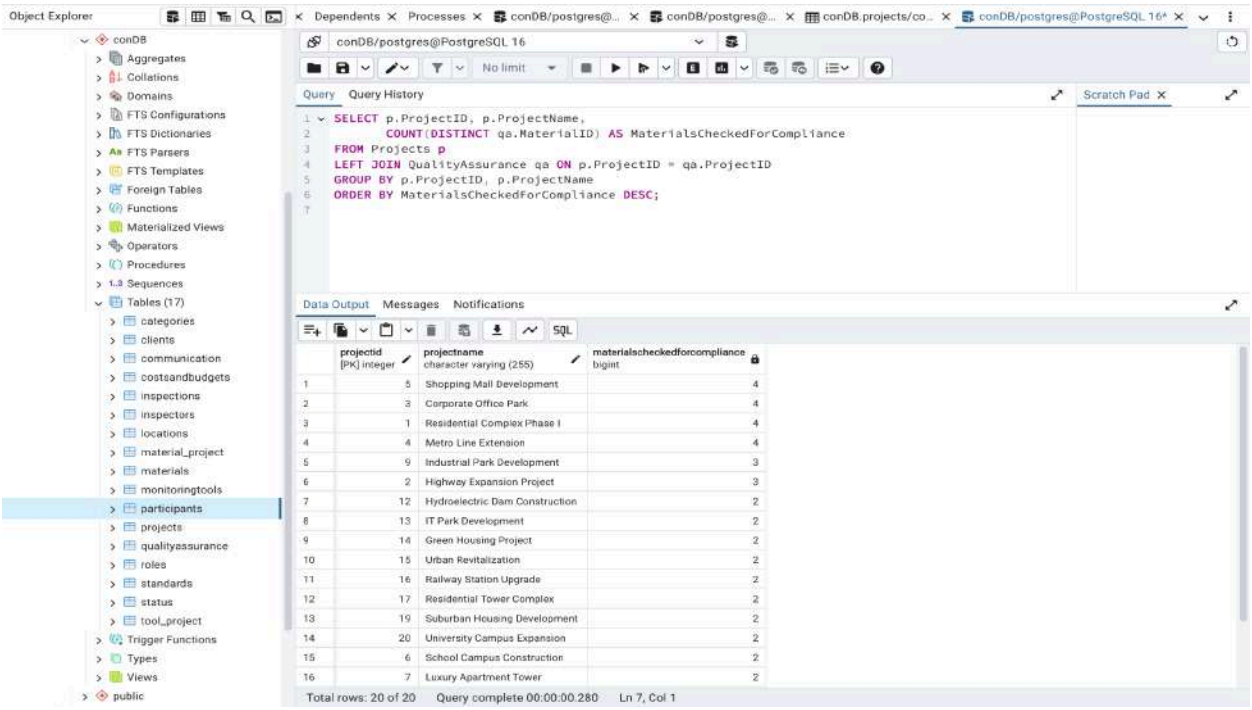
34. Find the most commonly used tools for each project (based on the number of times they are used).



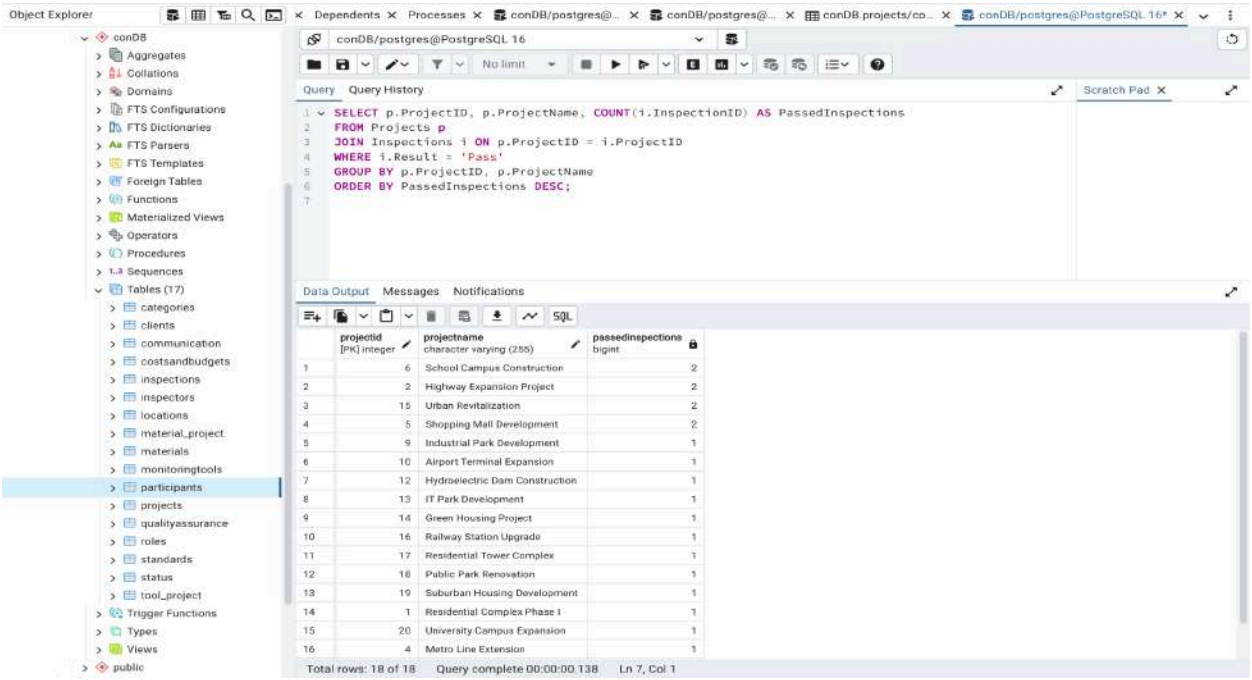
35. Get a list of projects with the number of participants and the total cost for each project.



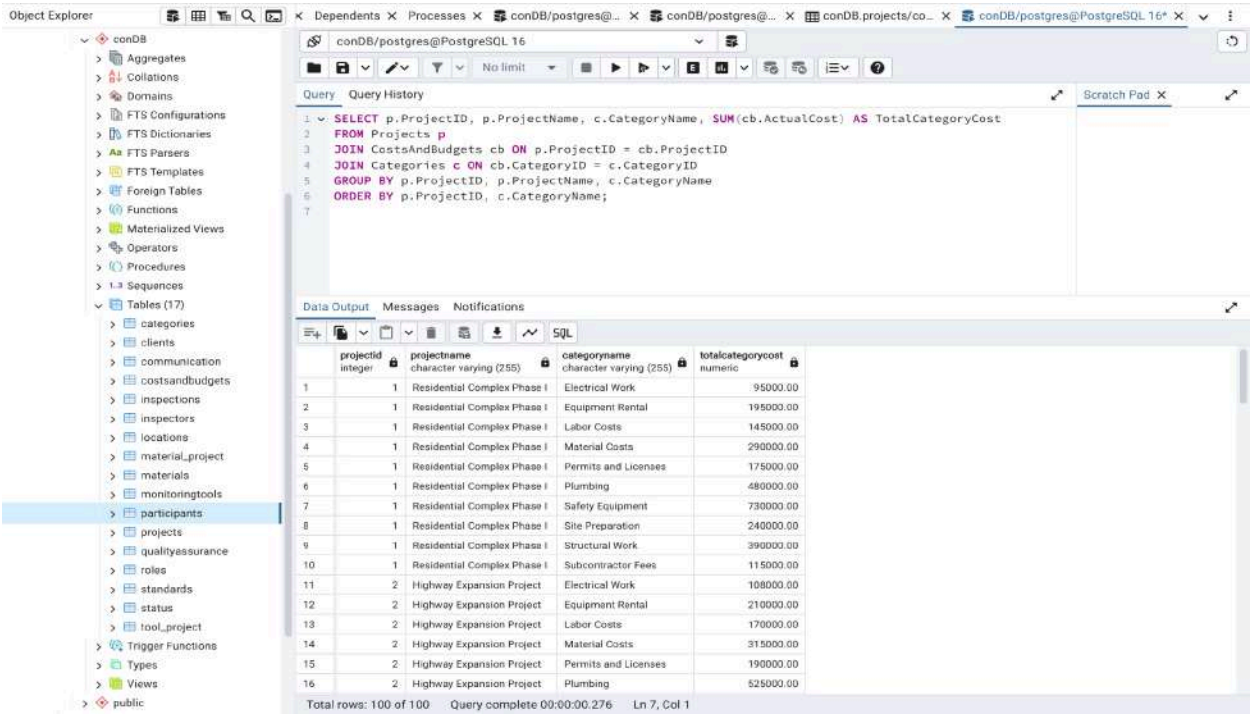
36. Find the number of materials checked for compliance in each project



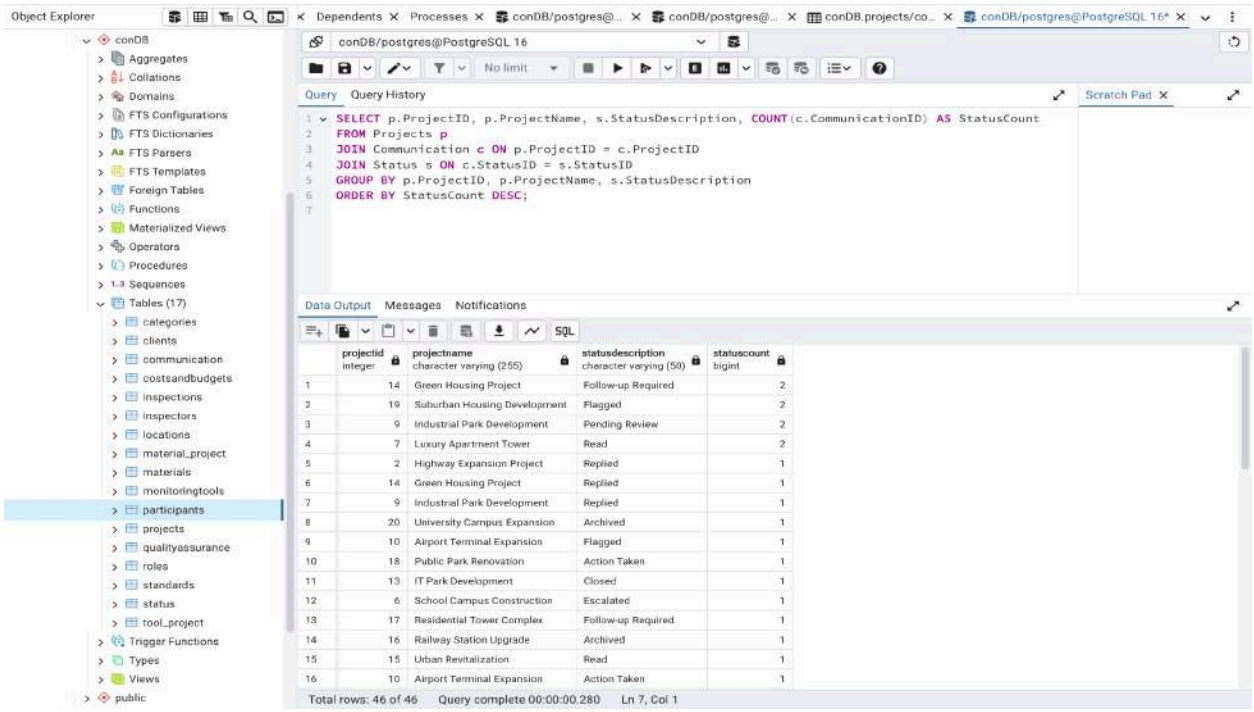
37. Get the projects with the highest number of inspections that passed.



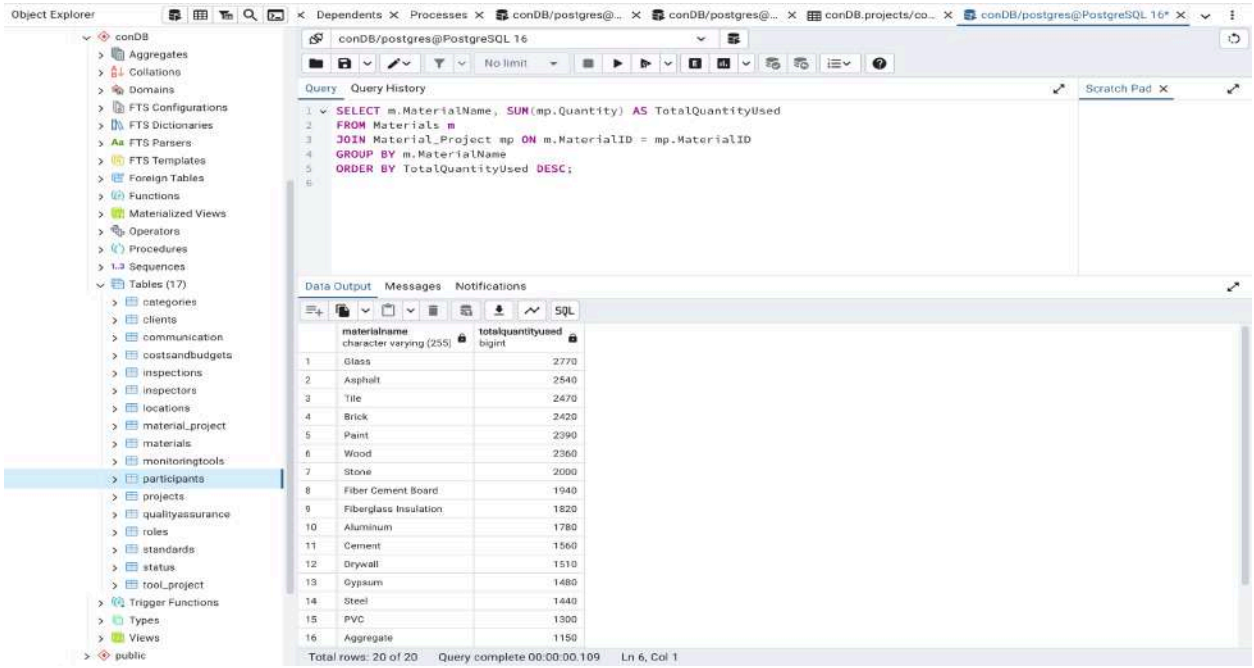
38. Get a summary of the cost breakdown for each project by category.



39. Find the most frequent communication status for each project.



40. Find the total quantity of each material used across all projects.



Chapter 5: Interface Implementation

Setup JDBC and Basic GUI

STEP 1
Our PostgreSQL Tables already exist in the Database "Conn_DB". Hence, No need to create them again.

STEP 2
JDK Already Installed on the System.
PostgreSQL JDBC driver (postgresql-42.7.4.jar) downloaded from the https://jdbc.postgresql.org/download/.

STEP 3
A New Project Directory was created called "postgreSQLCRUDApp" with sub-directory "src" for the JAVA Code.
The JAR file of JDBC postgreSQL Driver moved to src Folder.

STEP 4
Java Code file created called "ProjectManagement.java".
Code written to Create a Basic GUI and perform CRUD (Create,Read,Update,Delete) Operations

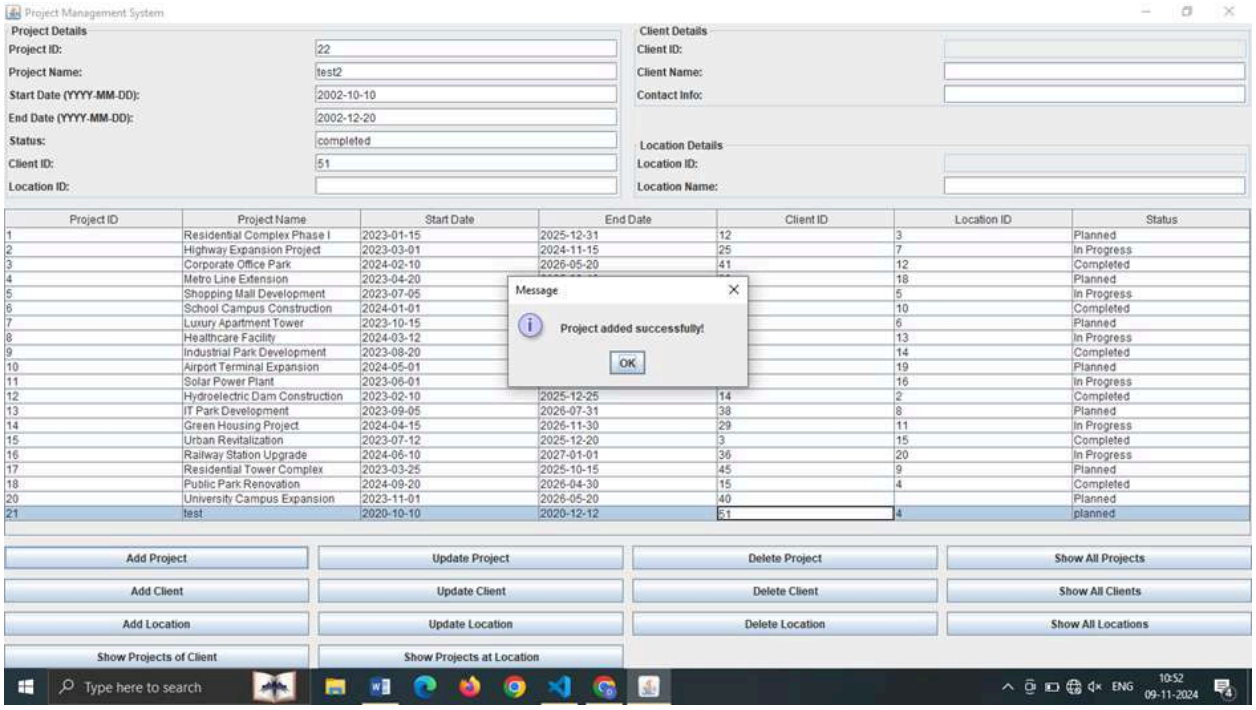
CRUD Operation on GUI

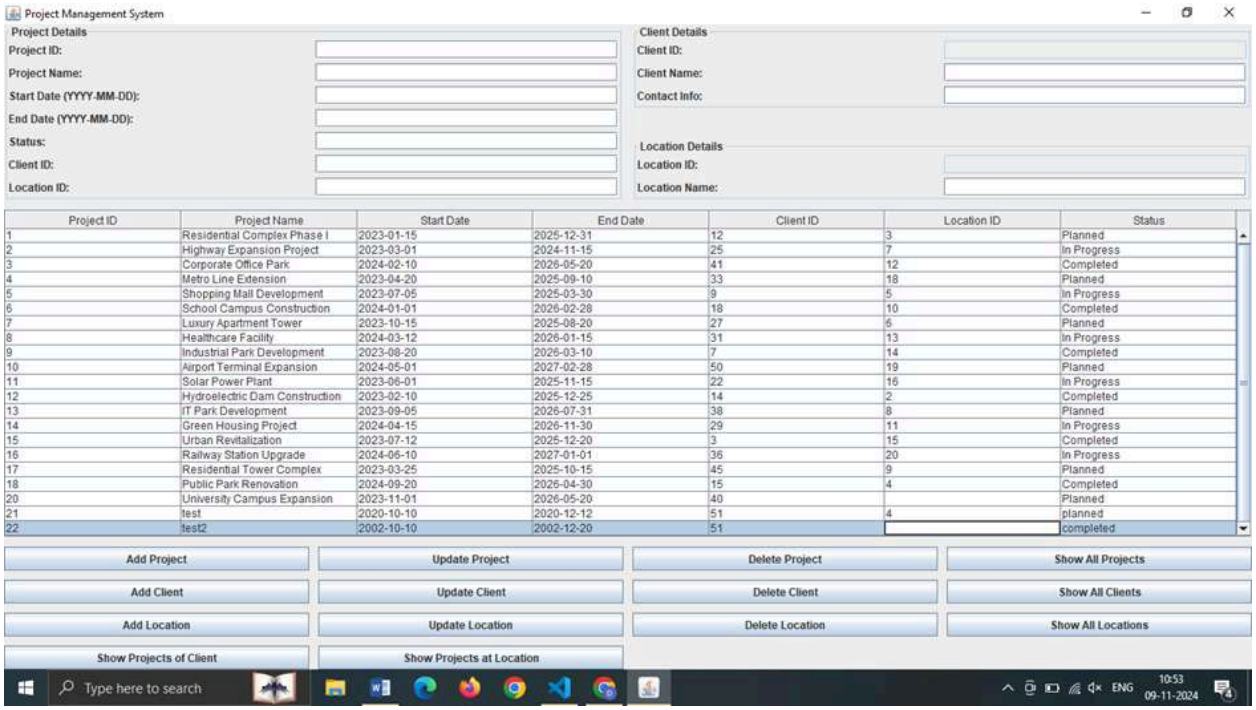
Tables:

1. Projects (ProjectID, ProjectName, StartDate, Enddate, ClientID, LocationID, Stats)
2. Clients (ClientID, ClientName, ContactInfo)
3. Locations (LocationID, LocationName)

CRUD Operations

1. Add Project





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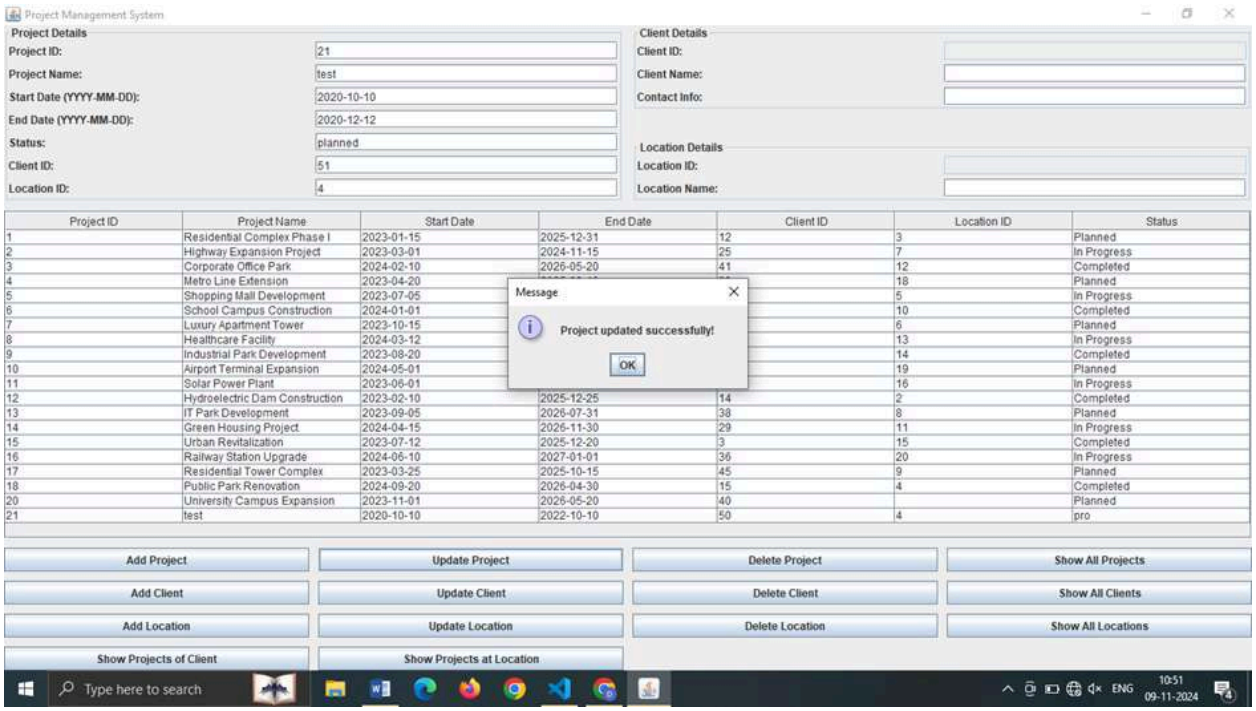

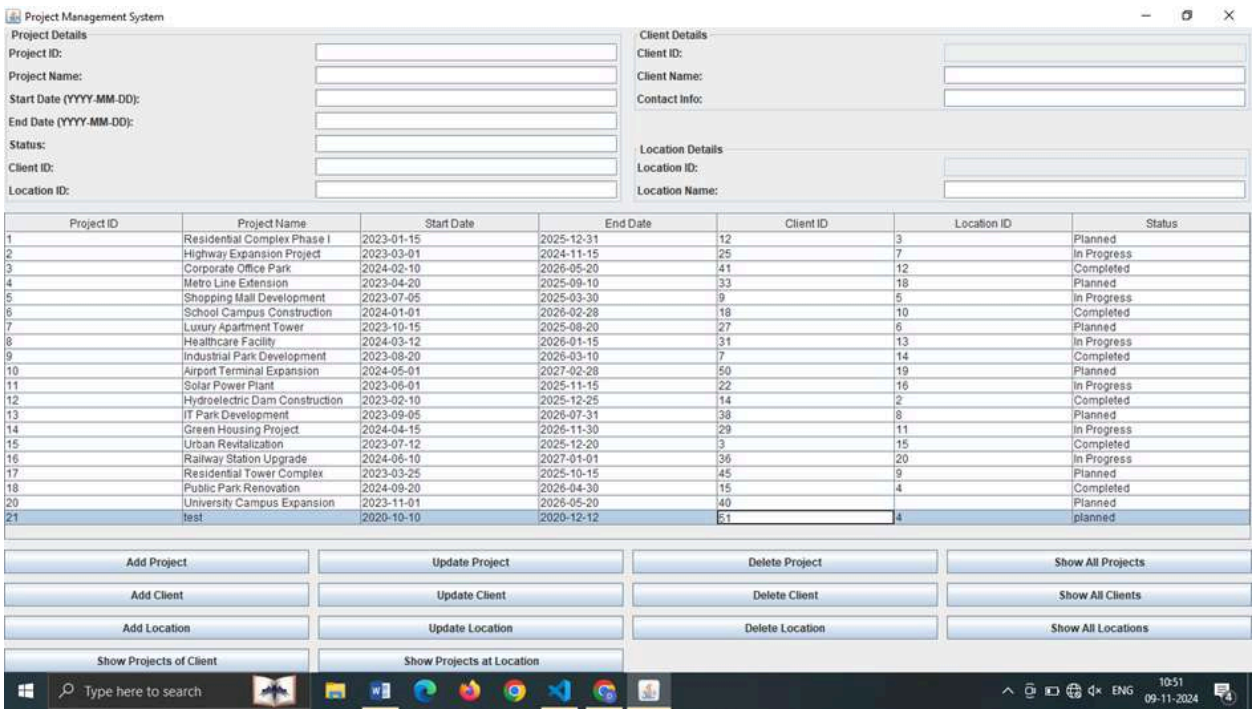

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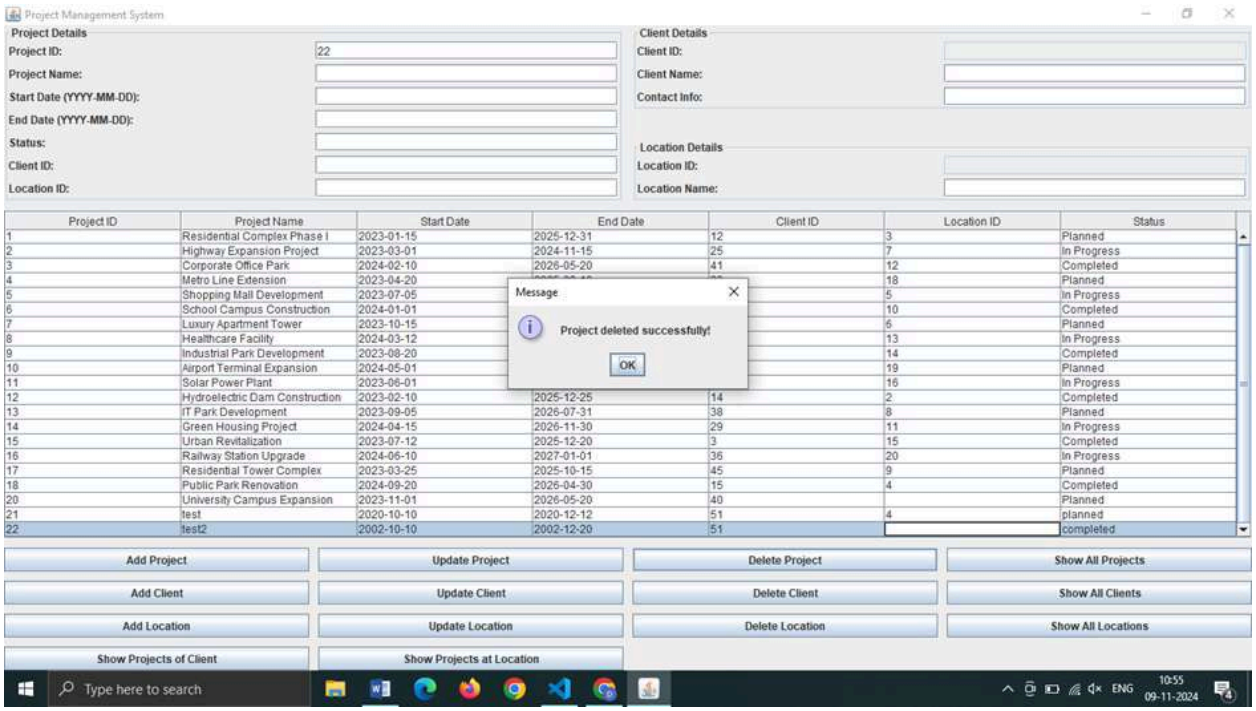
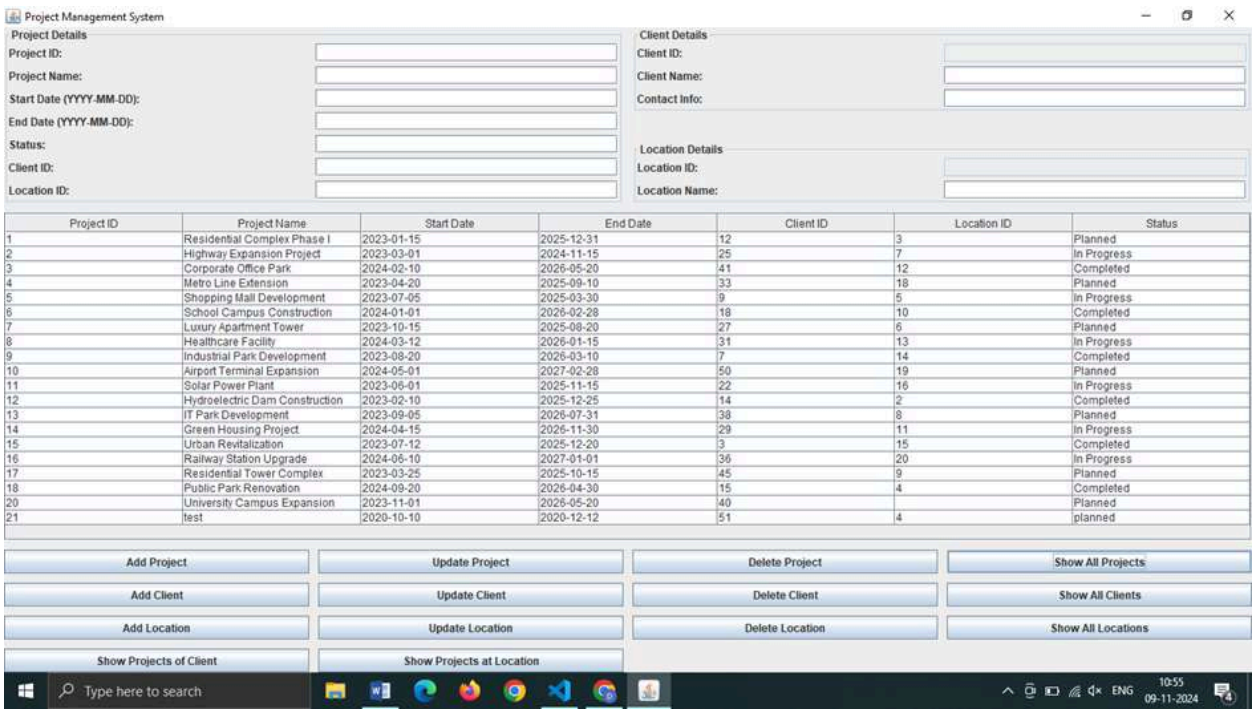
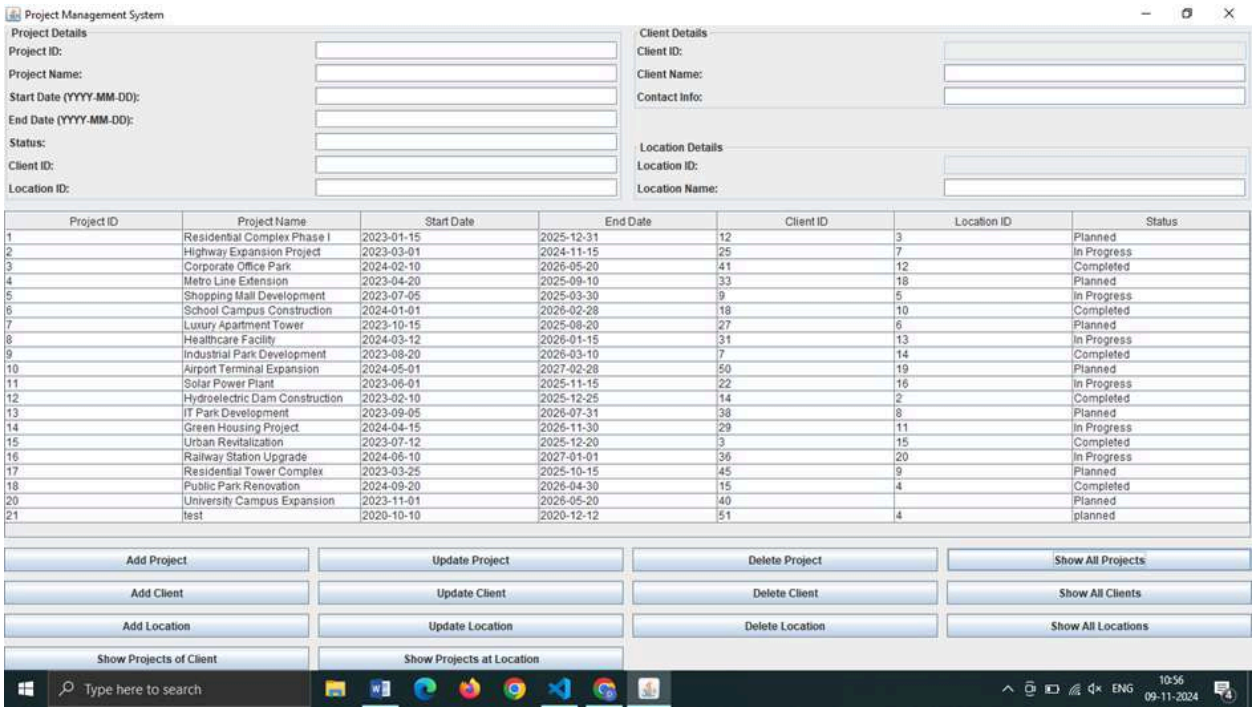




4. Show all projects



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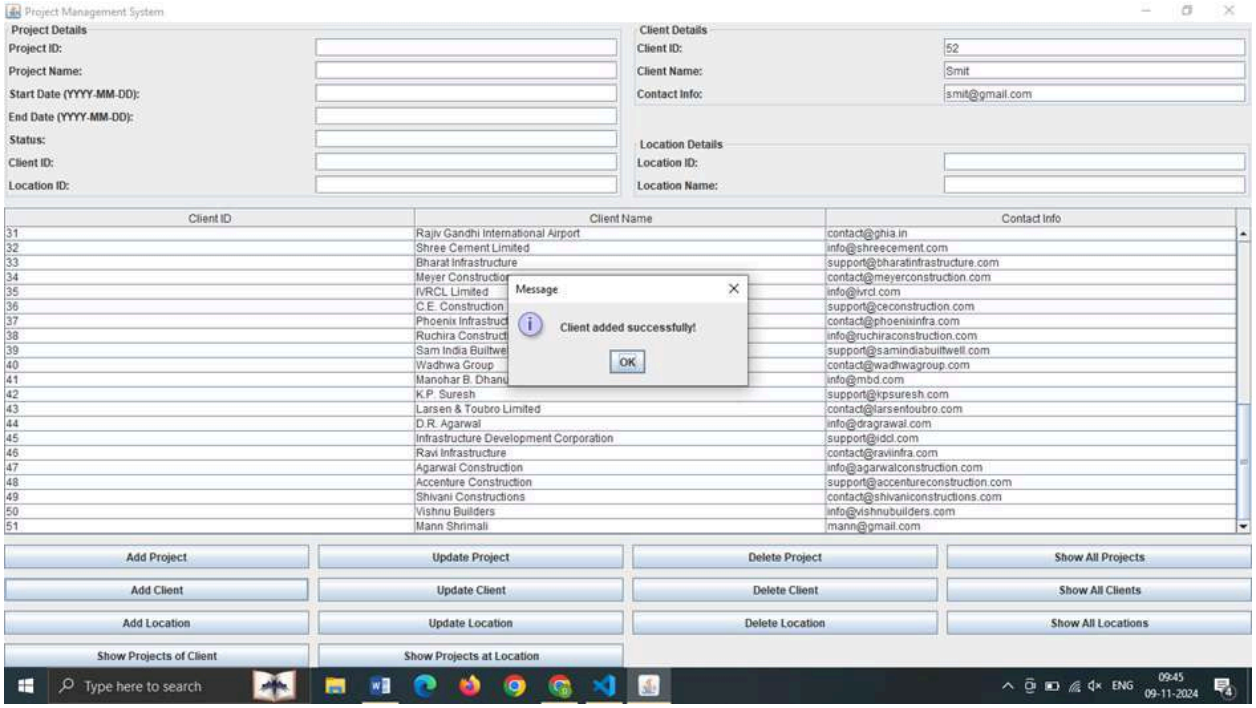

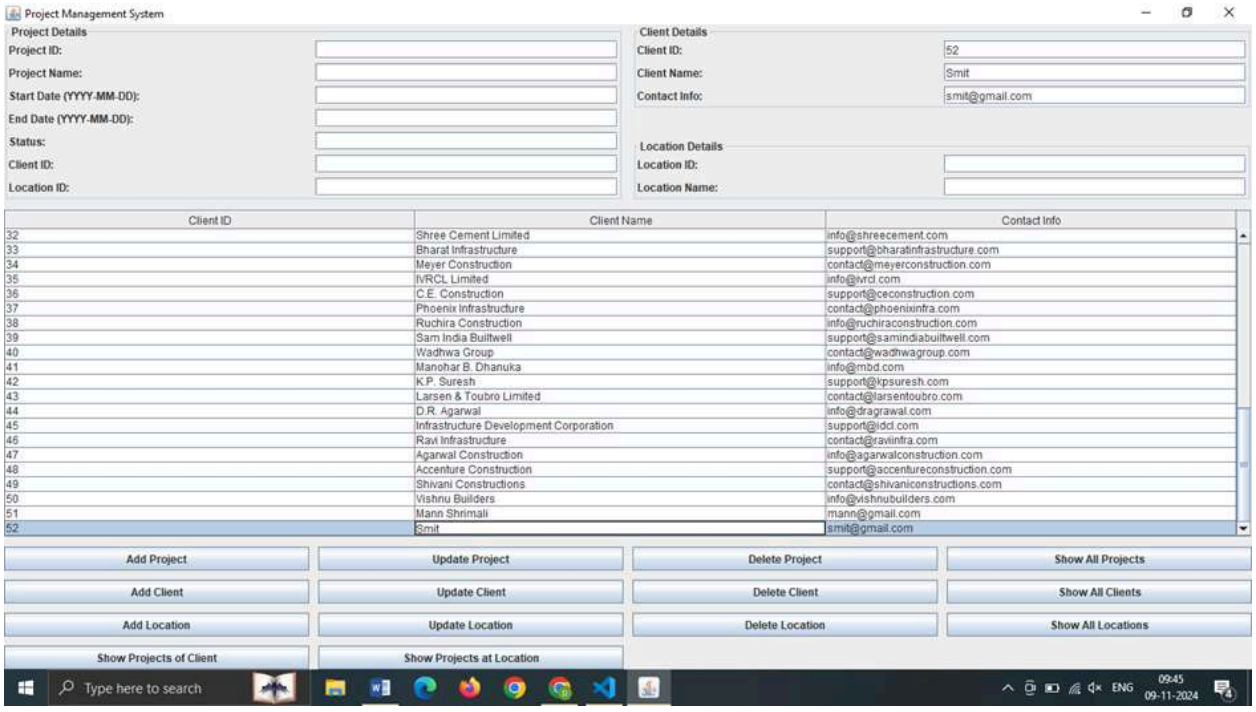

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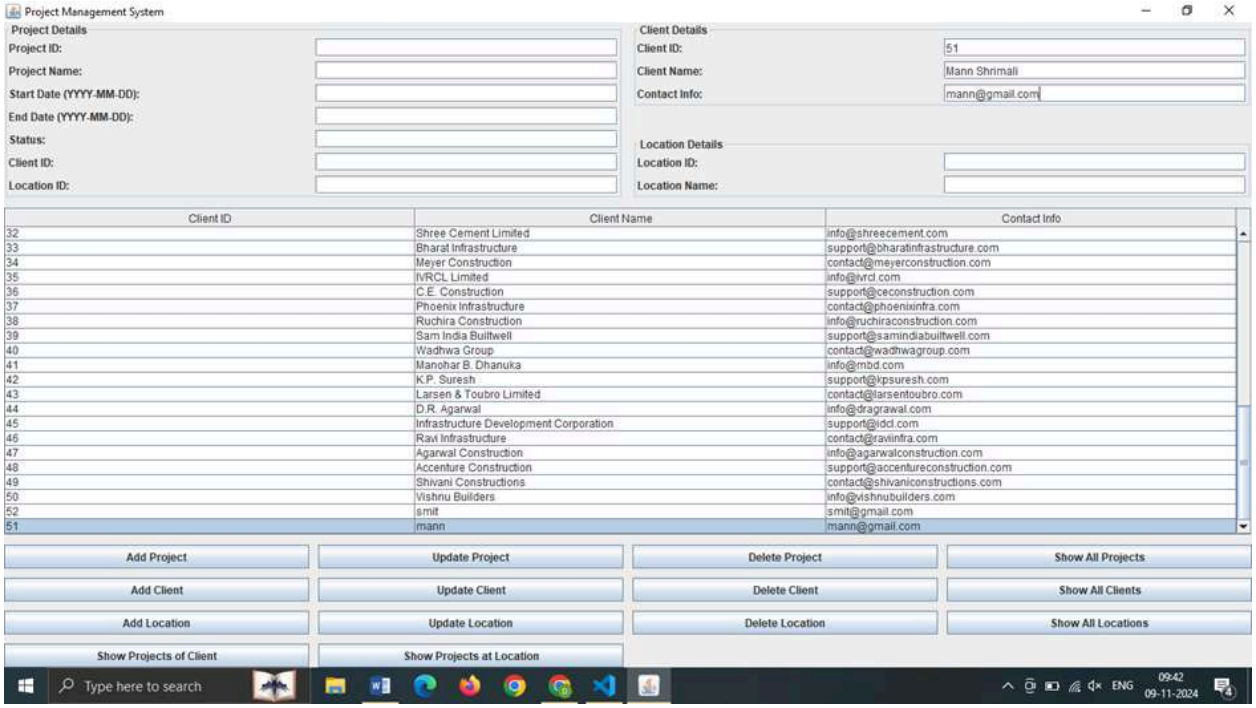

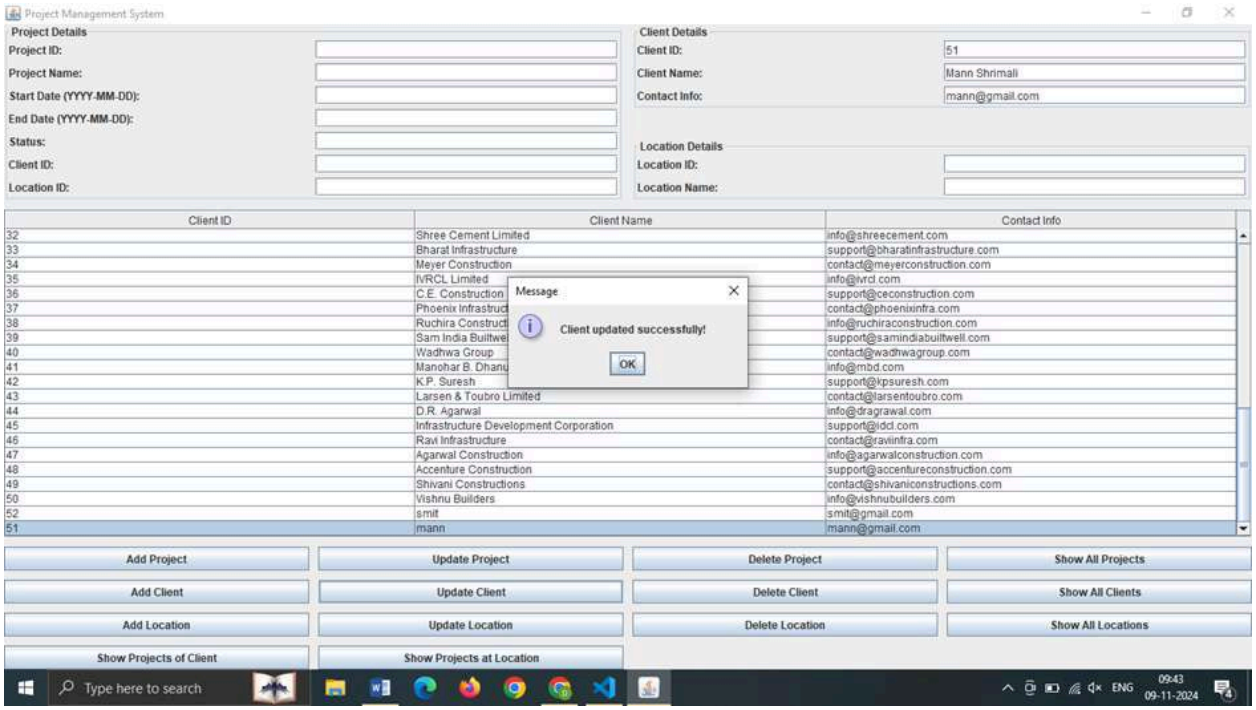

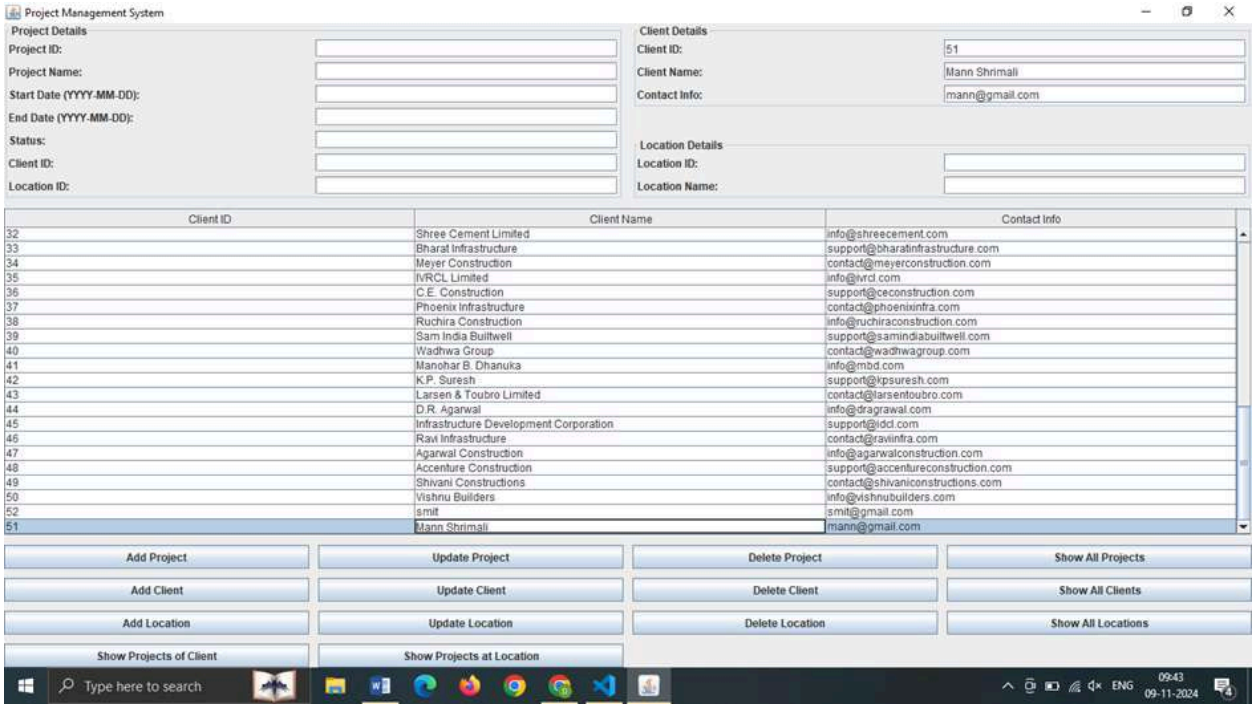
Project Management System
Project Details
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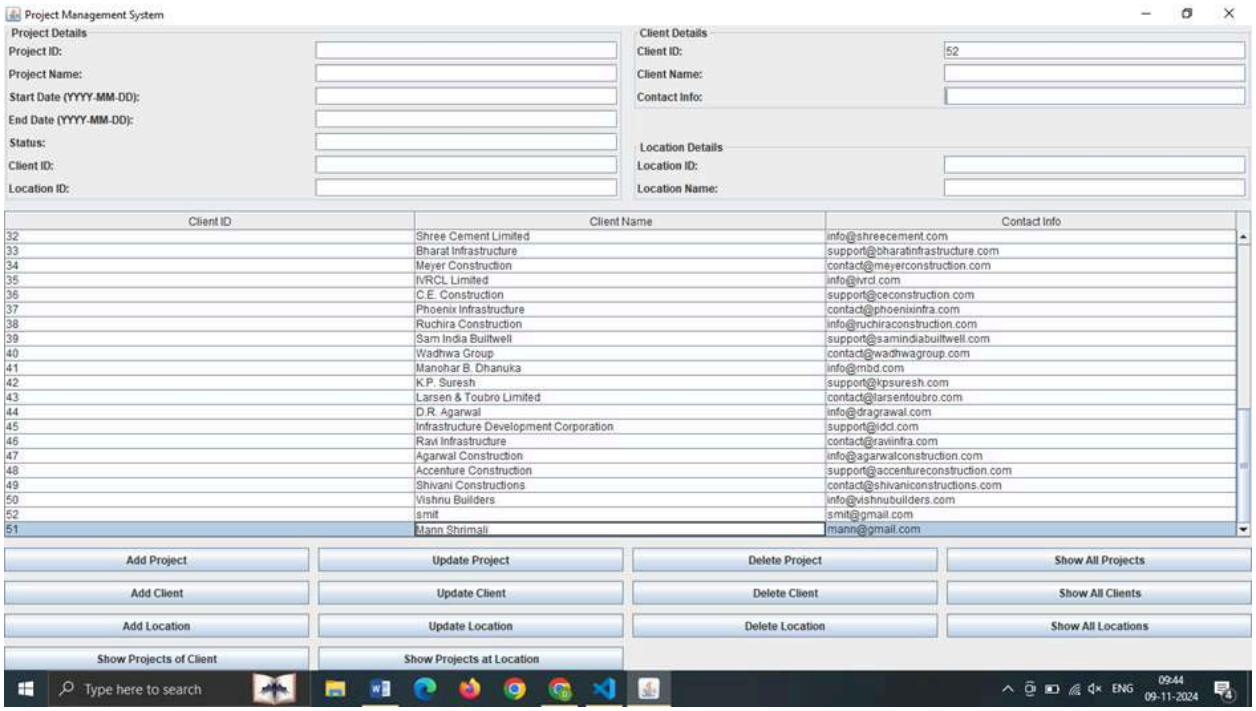
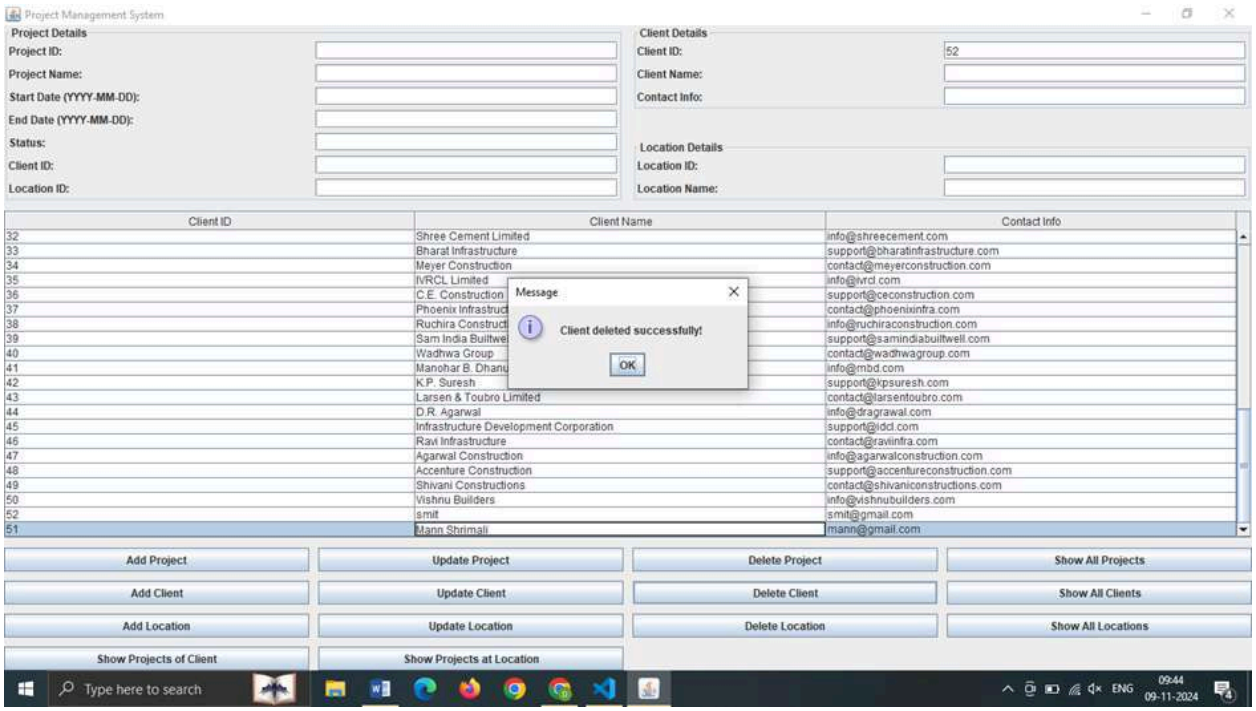
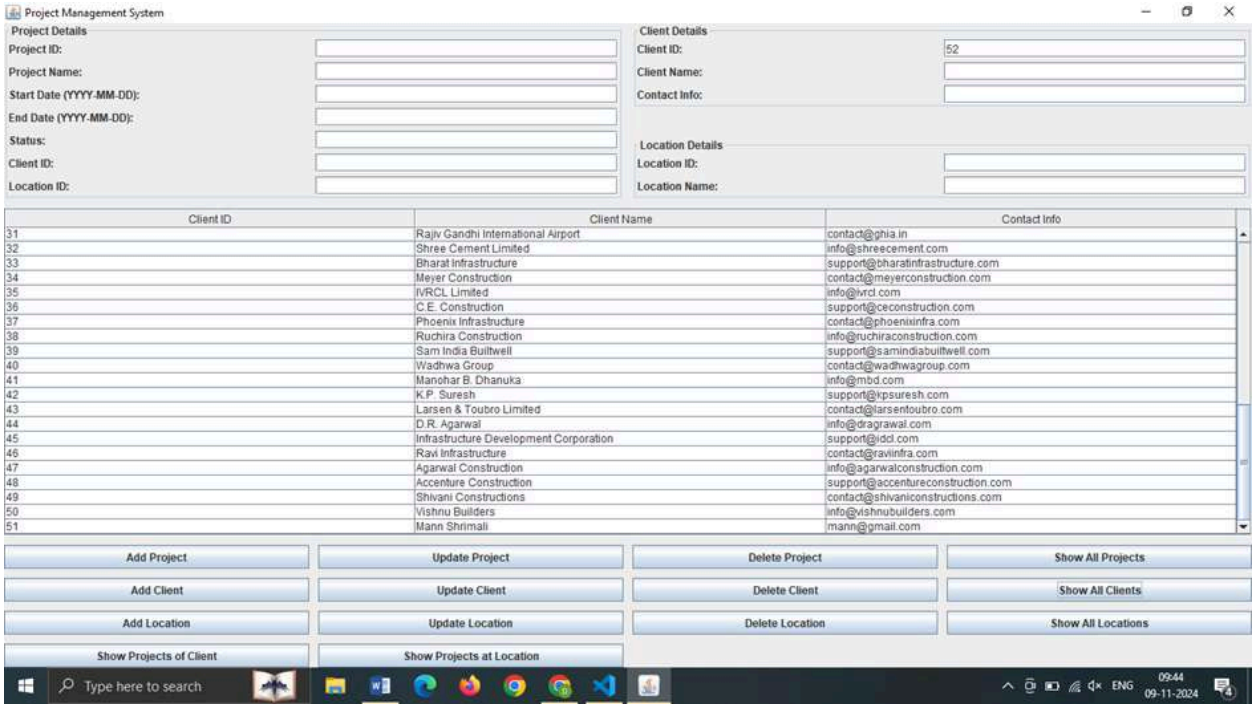
Project Name:
Start Date (YYYY-MM-DD):
End Date (YYYY-MM-DD):
Status:
Client ID:
Location ID:
Client Details
Client ID: 51
Client Name: Mann Shrimali
Contact Info: mann@gmail.com
Location Details
Location ID:
Location Name:
Client ID | Client Name | Contact Info
32 | Shree Cement Limited | info@shreecement.com
33 | Bharat Infrastructure | support@bharatinfrastructure.com
34 | Meyer Construction | contact@meyerconstruction.com
35 | IVRCL Limited | info@ivrcl.com
36 | C.E. Construction | support@ceconstruction.com
37 | Phoenix Infrastructure | contact@phoenixinfra.com
38 | Ruchira Construction | info@ruchiraconstruction.com
39 | Sam India Builtwell | support@samindiabuiltwell.com
40 | Wadhwa Group | contact@wadhwagroup.com
41 | Manohar B. Dhanuka | info@mbd.com
42 | K.P. Suresh | support@kpsuresh.com
43 | Larsen & Toubro Limited | contact@larsentoubro.com
44 | D.R. Agarwal | info@dragrawal.com
45 | Infrastructure Development Corporation | support@idcl.com
46 | Ravi Infrastructure | contact@raviinfra.com
47 | Agarwal Construction | info@agarwalconstruction.com
48 | Accenture Construction | support@accentureconstruction.com
49 | Shivani Constructions | contact@shivaniconstructions.com
50 | Vishnu Builders | info@vishnubuilders.com
52 | smit | smit@gmail.com
51 | Mann Shrimali | mann@gmail.com
Add Project
Update Project
Delete Project
Show All Projects
Add Client
Update Client
Delete Client
Show All Clients
Add Location
Update Location
Delete Location
Show All Locations
Show Projects of Client
Show Projects at Location
Type here to search
ENG
09:43
09-11-2024

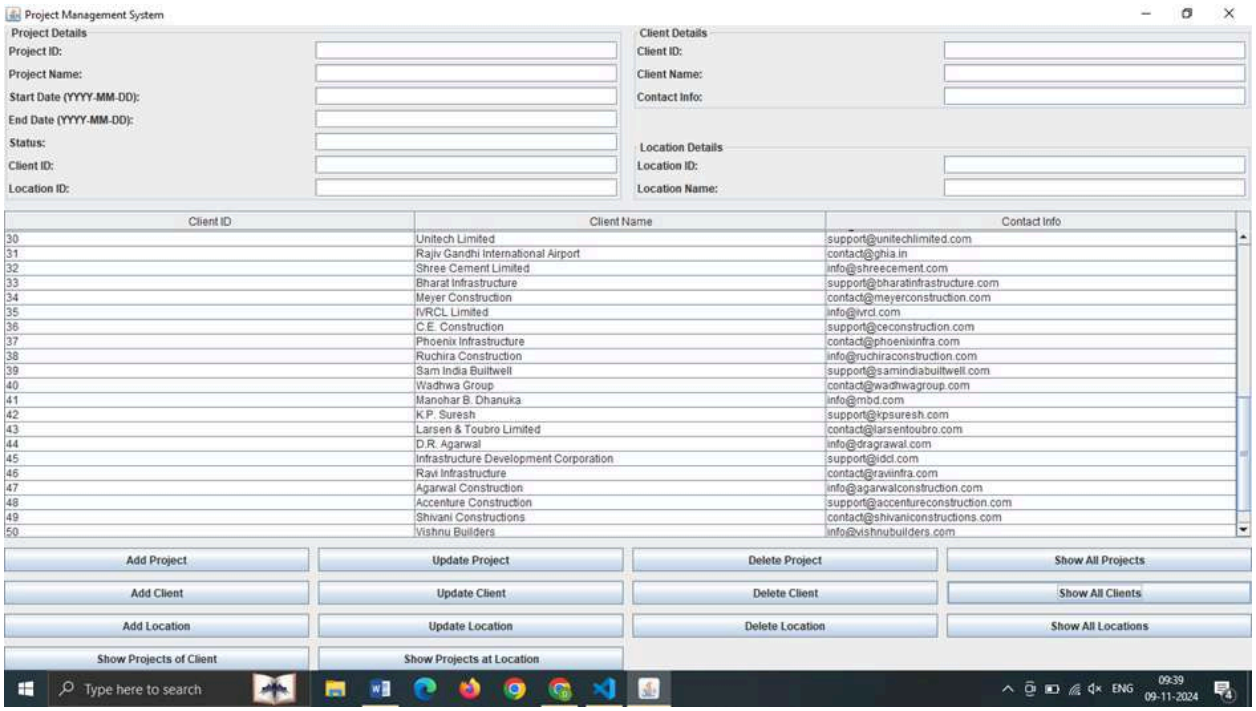
7. Delete client



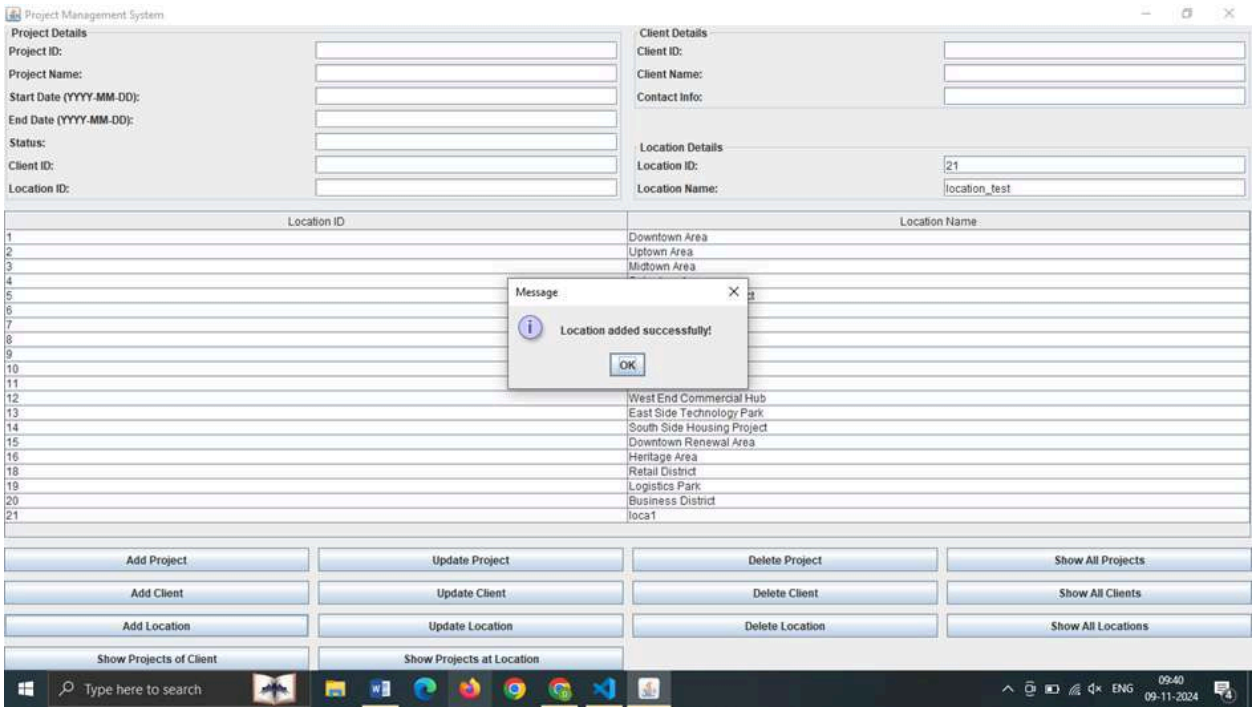


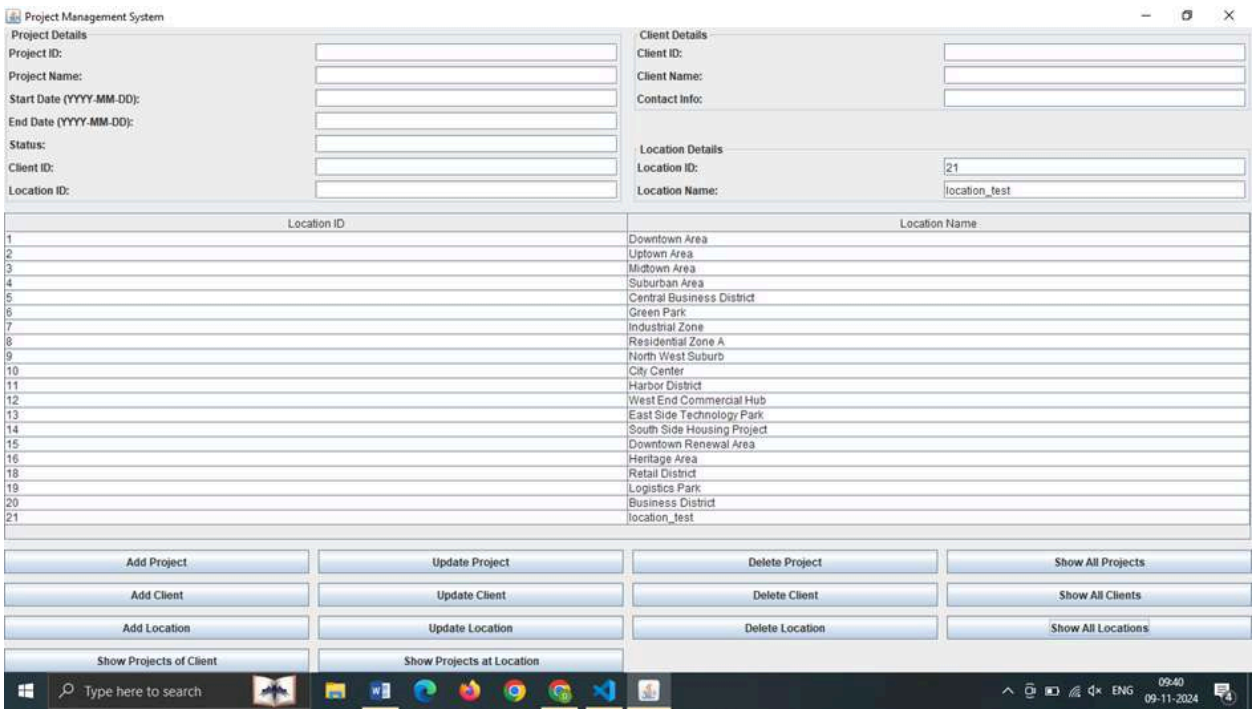


8. Show all clients

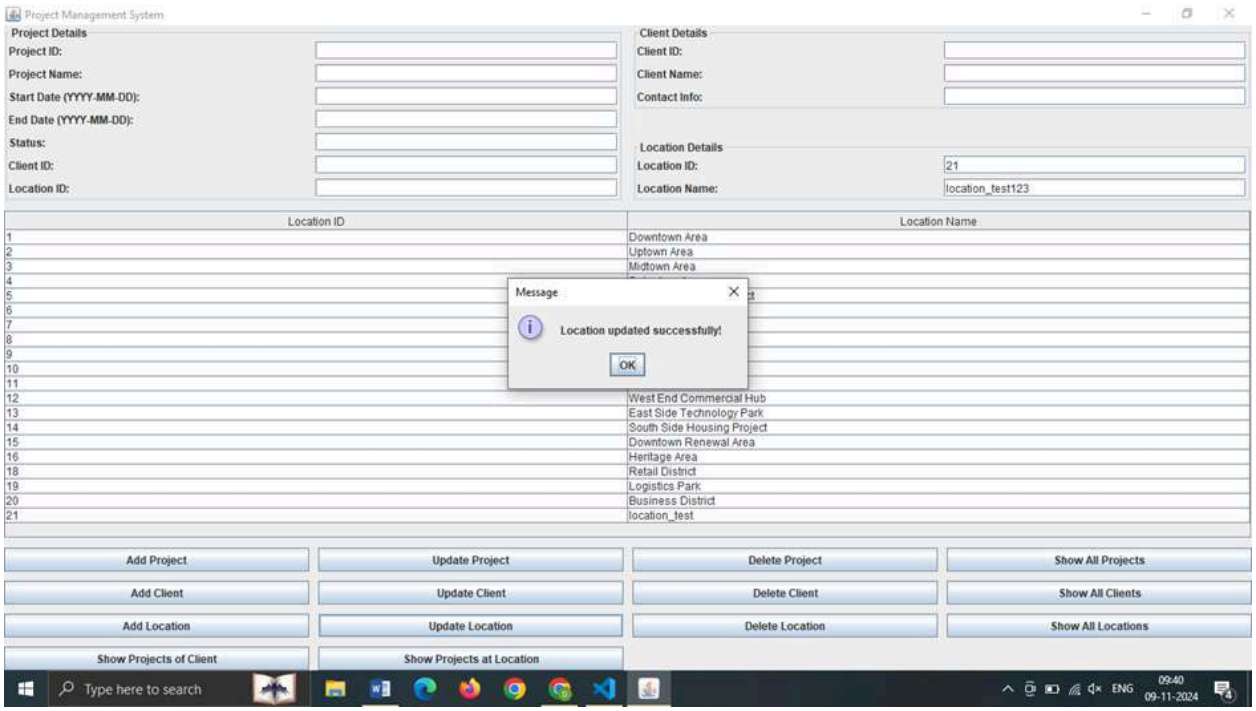


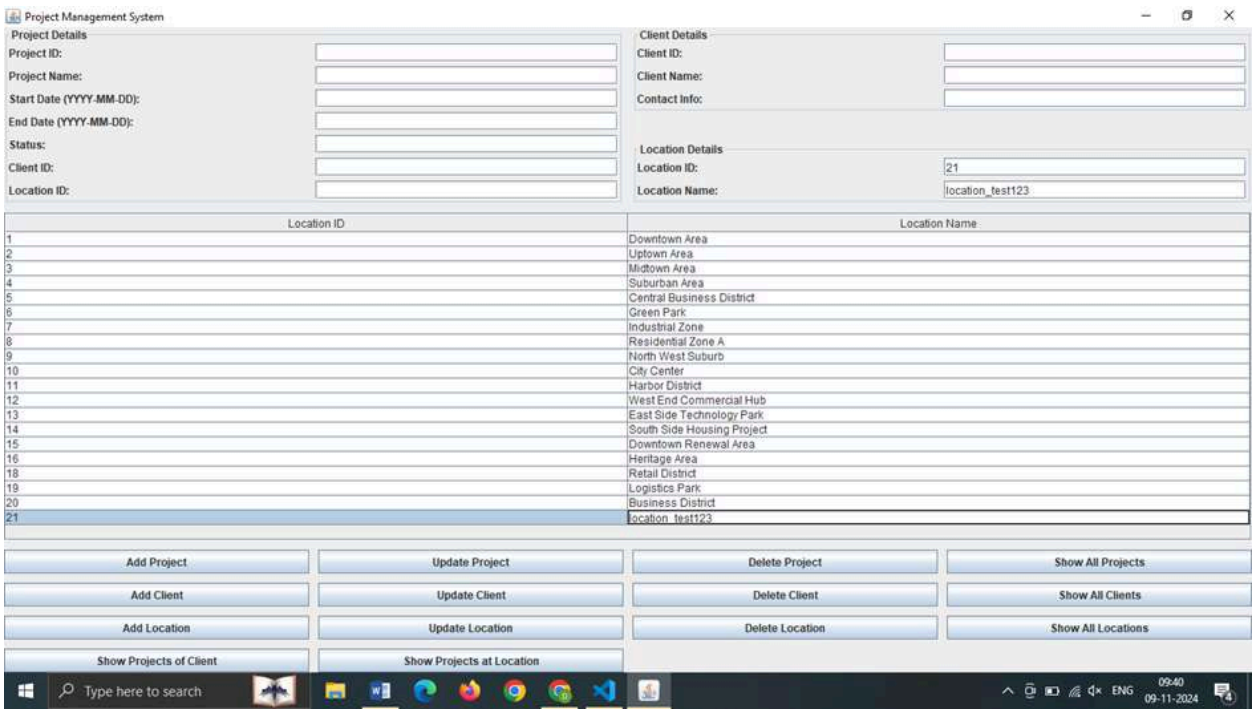
9. Add new Location



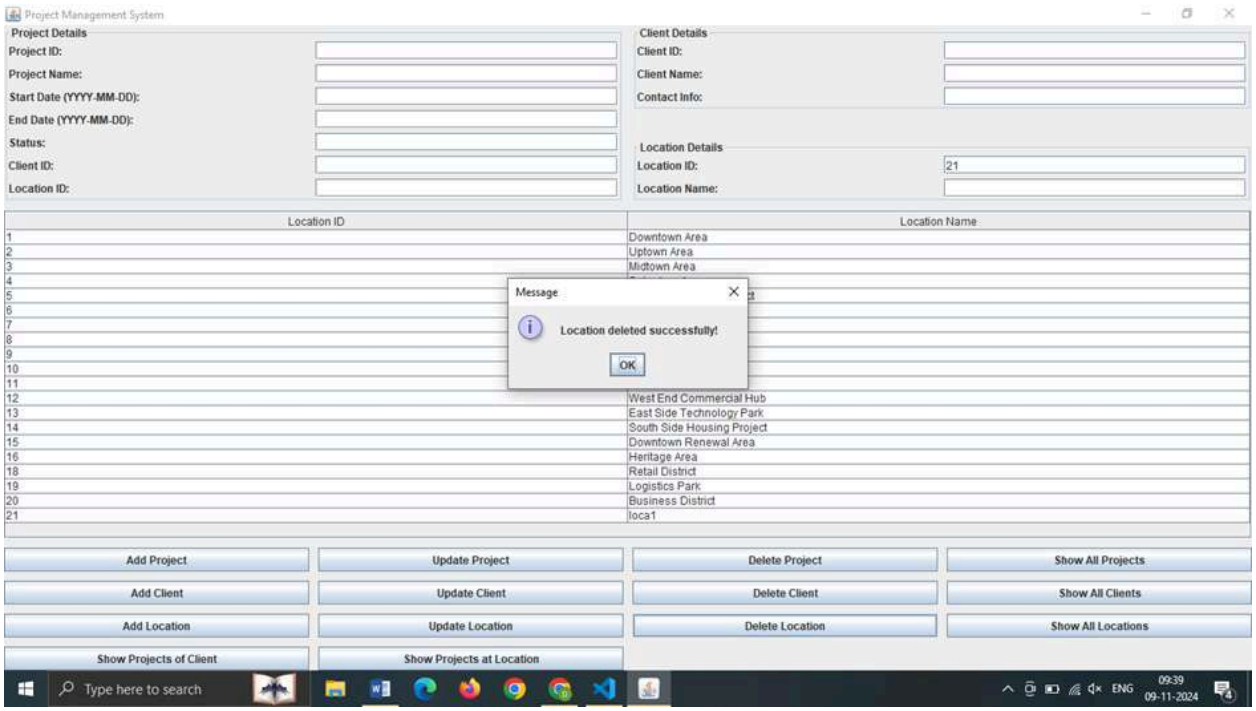


10. Update Location

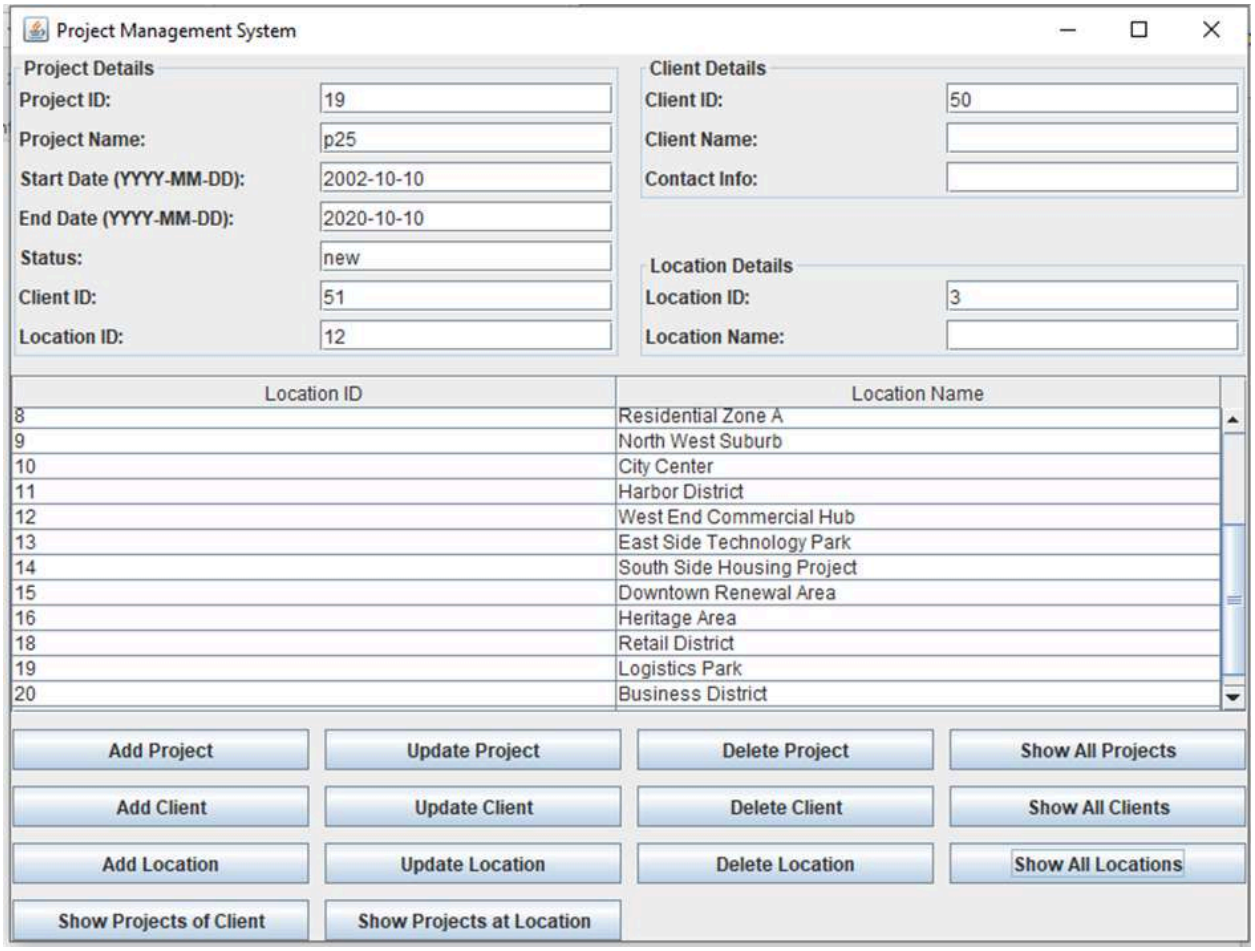




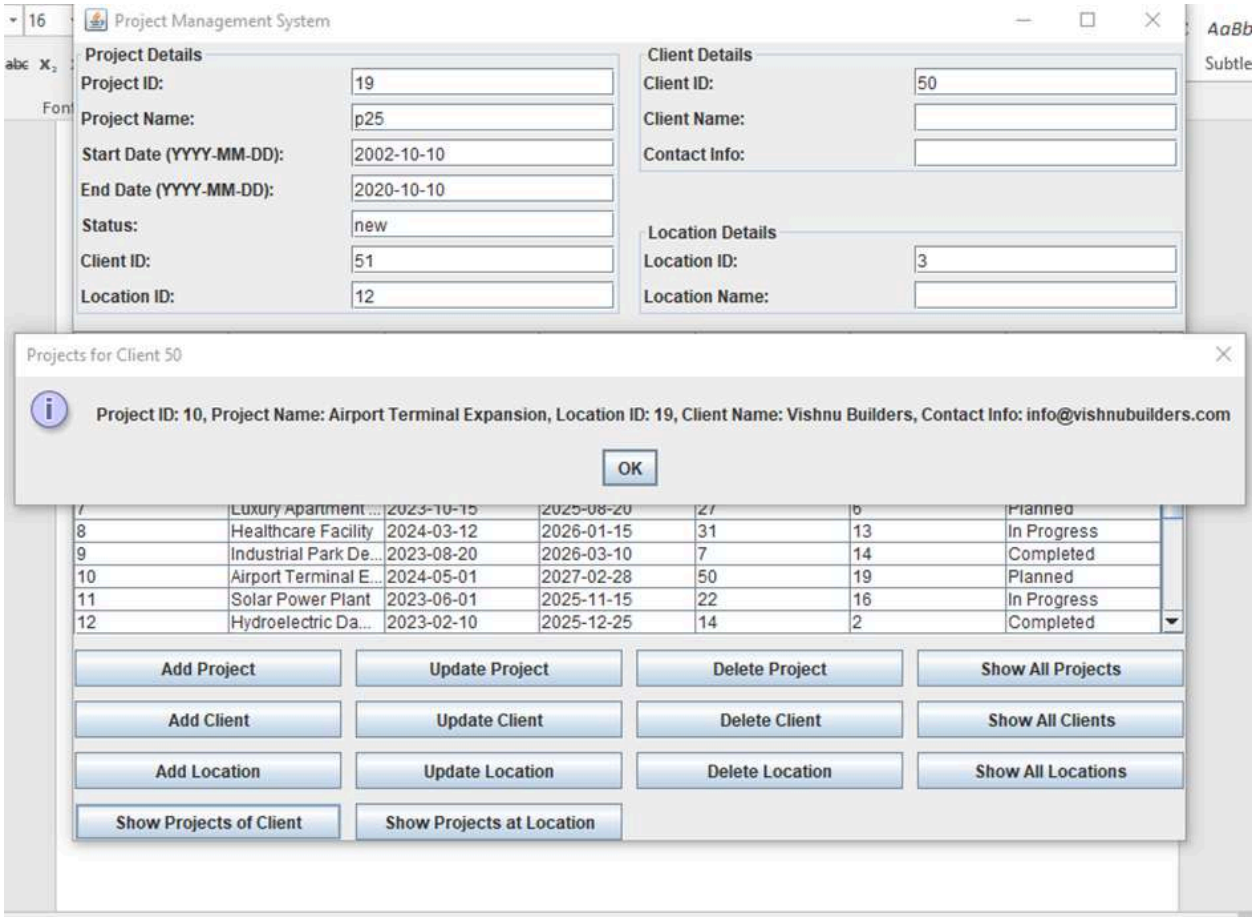
11. Delete Location



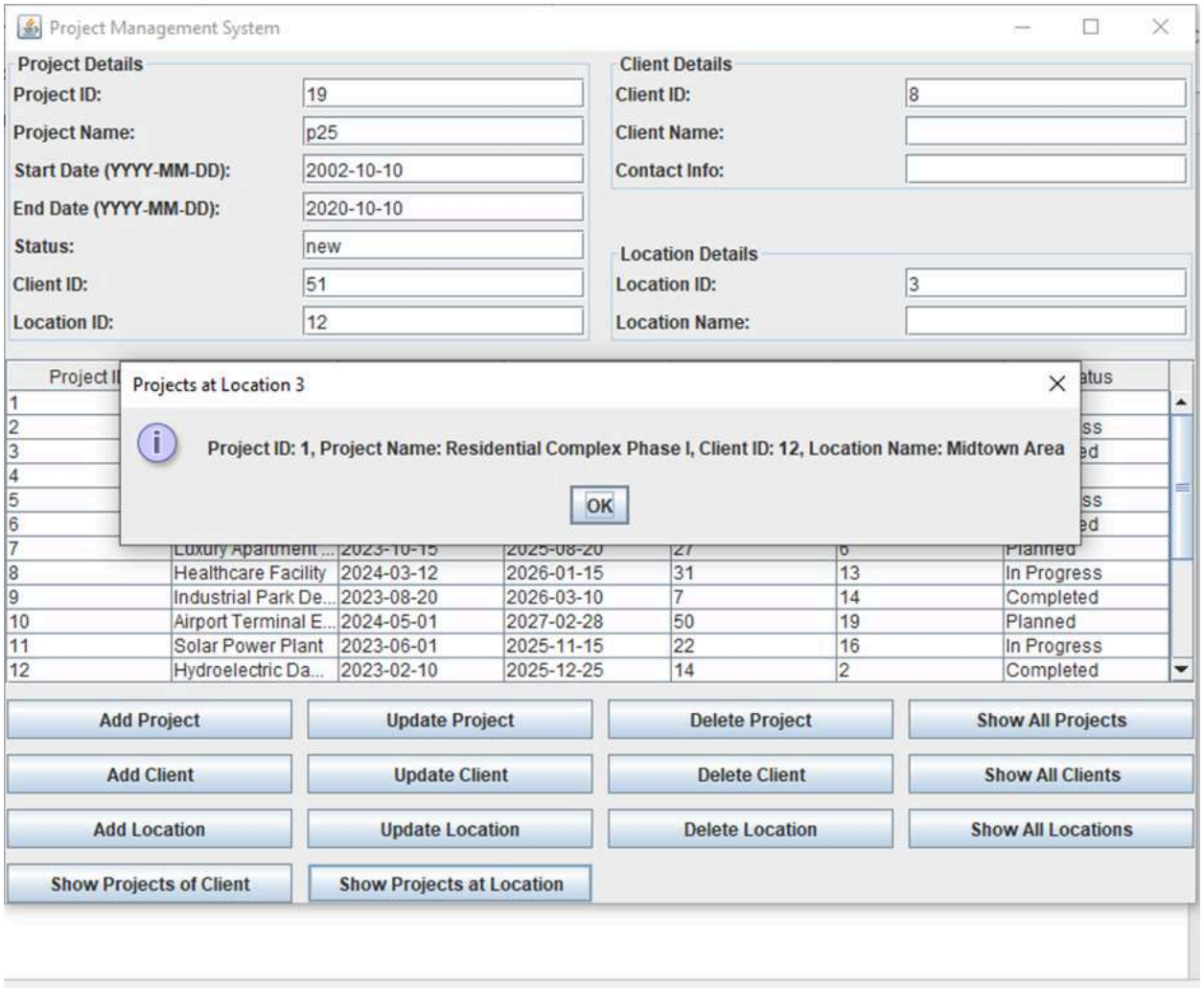
12. Show all Locations



13. Show all projects for particular client



14. Show all projects for given location



Chapter 6: Technical Issues and Solution

Technical Issues and Their Solution

Problem 1: Lack of Familiarity with Java Programming Language Syntax

Problem Statement:

We actually had a huge problem with Java because we were not familiar with its syntax and structure at least when faced with GUI development. We barely ever had a situation where we did not need to refer to some documentation, so we often faced unknown constructs, which caused delays and made the whole process much longer than it was supposed to be. This left us realizing how very important it was to have some basic understanding of Java before attempting complicated things.

Applied Solution

To counter this, we read documentation often and did exercises in debugging Java syntax. As a result, we gained familiarity with the language and its subtleties; this enabled us to incrementally work our way through the project. This exercise really went on to teach us how vitally important it is to conquer the basic principles of any programming language to successfully undertake highly technical tasks.

Problem 2: Problem in Identifying Data to Populate the Tables

Problem Statement :

It proved to be quite challenging to find realistic, constraint-compliant data to insert into our tables, especially when we ran into foreign key dependencies with the constrained data making sure it fitted in our rather complex schema. It was quite a challenge at the early stages of our work in finding data that could satisfy the relational requirements of the schema and integrity constraints.

Applied Solution

We used Python together with the Pandas library to produce random datasets that had attributes and were weighted with an aim of ensuring real world conditions to be represented. This allowed us to populate the tables with diverse yet compliant data sets, although it took a fair amount of time and effort in ensuring consistency across relationships.

Problem 3: Conversion of Database from 2NF to 3NF/BCNF

Problem Description:

The design of our initial database was in 1NF and 2NF but had to be changed to 3NF and BCNF, involving checking every dependency that required an inquiry into every attribute. Thus, every attribute was scrutinized, transitive dependencies were determined, and all non-prime attributes were ensured to be fully dependent on the candidate keys, which was very time-consuming and difficult.

Applied Solution

We did much in terms of research and defined hypothetical test cases with which we tested our transformations. This led us to identify and address problems, validate our normalization work, and, most importantly, ensure that the database remained well-structured, efficient, and fully normalized up to the higher normal forms.

Problem 4: Maintaining Referential Integrity Over Complex Foreign-Key Dependency

Problem Statement:

This made our construction industry database contain many linked entities, and referential integrity turned out to be tough to enforce. The constraints of the foreign keys could not easily be broken during update and delete operations. Cascading updates were found to be one of the main obstacles in creating a complex relationship.

Applied Solution :

We also executed each transaction carefully enough to not leave behind orphaned records by mistake or integrity violations. With the ability to support cascading updates and rollbacks, we ensured that the integrity of the database was maintained with respect to interdependencies across multiple interdependencies. Testing this became vital to prevent referential integrity issues as the schema grew complex.

Problem 5: Limited Domain Knowledge of the Construction Industry

Problem Description:

It was something new to us, so we had to do a lot of research to understand the database requirements of this particular domain. This project threw open concepts that ranged from material tracking to participant management. This was time-consuming and felt like a heavy burden to carry.

Applied Solution :

This experience was through extensive research, which kept us familiarized with construction industry operations in terms of the interactions of various entities present in a construction site. This knowledge improved the effectiveness of our project and increased our practical expertise to enable us to gain a greater view of the applications in the real world.

Issue 6: Niche Domain with Limited Background Resources

Problem Description:

This domain of database management in the construction site is niche, with limited, fragmented resources available. Construction data management was among such niche domains which had very few cohesive references to refer from and thus gave rise to the problem of getting wholesome information.

Applied Solution

Littered literature and industry-specific studies were gathered as pieces of insights thereby piecing together a workable understanding of construction data requirements. This was an approach to overcome the lack of resources with a consolidated effort though it required additional effort to compile all relevant information.