Construction Projects Progress Monitoring and Tracking using a Mobile Application

Final Year Project UG 2020

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CERTIFICATION

This is to certify that

The Final Year Project Titled

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ABSTRACT

The passage delves into the shortcomings of outdated monitoring systems in project management, emphasizing their inefficiencies in keeping up with technological advancements. It highlights how reliance on manual, paper-based data collection hampers real-time progress tracking, leading to errors and delays in project completion. While innovative technologies like LiDAR offer precise mapping, their prohibitive costs and complexity limit their adoption, especially for projects with tight budgets. This creates a gap in accessibility, exacerbating challenges during unforeseen events and diverting focus from resolving issues to merely containing them.

However, the narrative presents a hopeful alternative in modern mobile applications tailored for project management. These apps offer a more practical, cost-effective solution by simplifying operations and enhancing collaboration among project members. By enabling real-time data capture and automated financial tracking, they address critical needs for efficient budget management and streamlined communication. Usability tests demonstrate their potential in improving efficiency and streamlining processes, paving the way for a future where project management is more responsive and adaptable to the dynamic challenges of the modern world.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF ABBREVIATIONS AND ACRONYMS

API	Application Programming Interface
AI	Artificial Intelligence
GPT	Generative Pre-Trained Transformer
API	Application Programming Interface
GUI	Graphical User Interface
ICT	Information and Communication Technologies
RII	Relative Importance Index

CHAPTER 1
INTRODUCTION:

1.1 GENERAL

The process of project sign-off in the construction sector is not merely an activity to mark the completion of a project by a specific deadline. Instead, it encompasses a complex blend of processes aimed at fulfilling client requirements, optimizing costs, and creating a positive market impression (Abeysinghe and Jayathilaka, 2022). Successfully signing off on a construction project involves meeting a myriad of intricate objectives, each contributing to the overall success and reputation of the construction firm involved.

However, the construction industry, particularly in developing countries, faces significant challenges in achieving timely project completion. The lack of necessary skills and expertise for effective project execution is a considerable burden. Developing countries are often beset by planning constraints, substantial budget deficits, and cumbersome institutional regulations, all of which significantly slow down the progress of construction projects. According to the Asia Development Bank (ADB) in its Report on Infrastructure Development in Asia, these impediments lead to chronic delays and inefficiencies.

ADB studies indicate that construction projects in the Asia-Pacific region experience delays averaging 30%, highlighting a pervasive issue across the sector. These delays are not merely missed deadlines; they entail massive cost escalations, contractual disputes, compromised quality standards, and even safety hazards on construction sites. The Arcadis Global Construction Dispute Report 2019 corroborates this by revealing that 89% of construction disputes are caused by on-site delays, with the average value of these disputes being substantial.

Effective project monitoring is critical to achieving the intended objectives of construction projects. Proper and efficient monitoring can successfully identify and trace the delays that projects encounter, thereby avoiding potential pitfalls (Kopsida & Vela, 2015). Conversely, ineffective monitoring methodologies can prolong project timelines and hinder the achievement of project goals (Park et al., 2019).

Unfortunately, many construction projects today lack the technological advancement needed for modern monitoring techniques. Instead, they rely on outdated methods such as manual data collection, paper records, and irregular site inspections. These traditional practices are notorious for their shortcomings, including significant time expenditures, error proneness, and the absence of real-time data acquisition capabilities (Brady et al., 2018).

For a long time, these traditional methods were considered the only viable approach to project monitoring. However, it has become increasingly clear that they are inadequate, leading to delays and inefficiencies due to errors and the lack of real-time data. Dependence on such outdated methods increases the likelihood of confusion and misunderstandings during the project lifecycle, often resulting in schedule slippages and budget overruns (Navon & Sacks, 2007). As a result, the construction industry has recognized the urgent need to transition to more advanced and streamlined project monitoring methods.

Transparency and effective communication are critical components of successful project management. When these elements are lacking, traditional practices tend to fail, leading to opacity and disjointed communication. This hinders the collaborative efforts required for project success. Therefore, in the context of project monitoring, there is a well-deserved emphasis on adopting modernized methods that facilitate collaboration, transparency, and informed decision-making.

Innovative solutions such as real-time data acquisition technologies, advanced project management software, and integrated communication platforms are increasingly being recognized as essential for modern construction project management. These tools enable project managers to monitor progress accurately, make data-driven decisions, and maintain clear communication channels among all stakeholders.

In conclusion, the evolving demands of the construction industry necessitate a shift from traditional, outdated monitoring methods to more advanced, efficient, and transparent practices. Embracing these modern techniques will not only enhance the ability to meet deadlines and optimize costs but also improve overall project quality and safety. As the construction industry continues to grow and develop, the adoption

of innovative monitoring solutions will be crucial in overcoming existing challenges and achieving sustained success.

1.2 PROBLEM STATEMENT

Moreover, the sectors of transport and industrial production, unlike other areas, involve stringent requirements that necessitate not only choosing a specific date but also adhering rigorously to the schedule. This complexity underscores the critical assertion that such policies, if not managed properly, can lead to prolonged periods before goals are achieved. Furthermore, these policies determine the final characteristic margin per unit, ultimately influencing the market's long-term dominance. According to recent analyses, several national governments have already begun adopting the diverse objectives outlined in the Sustainable Development Goals (SDGs) 2030. However, the issue of adhering to deadlines remains a persistent challenge, as the implementation of SDGs 2030 is hampered by various complications.

At the project level, complex scheduling contributes to significant overruns, with sophisticated technical difficulties often being underreported. The Asian Development Bank (ADB) report supports this view, highlighting that project delays in the Asia-Pacific region often result in a 30% overrun due to such complications. Additionally, the ADB notes a significant reduction in consumption speeds in the Pacific region, which have declined by 30%, double the previous rate. This decline further exacerbates the challenges faced in maintaining project schedules and achieving timely completions.

To mitigate these issues, it is essential to ensure the successful delivery of the required quantities with all the specified qualifications. This approach is crucial for reducing transportation expenses, notwithstanding the challenges that may increase costs, conflicts, safety, and quality issues. One of the most common sources of project delays is the extension of the building schedule, among other factors. By 2019, such delays had contributed to nearly $37 million in additional costs in the construction process. Addressing this issue effectively requires a more comprehensive approach

than merely issuing licenses. The establishment of an extraction plan and the prioritization of development needs over economic considerations are critical steps.

Effective communication and coordination between the primary institutions, rather than just the assigned entities, are vital for ensuring planned success and timely project delivery. The role of the operation manager is pivotal in maintaining a clear line of command and ensuring that project timelines are adhered to. Central to project time management is the concept of time frame monitoring, which is one of the most significant factors contributing to project progress delays. Studies by Kim et al. (2019) and Park et al. (2019) highlight the importance of this element.

In contrast to traditional methods, which rely heavily on site visits, manual monitoring, field inspections, and reporting, modern approaches leverage advanced technologies such as data acquisition systems, software, machinery, and wireless communication systems. These technologies represent the latest advancements in project management and offer significant improvements over conventional methods (Brady et al., 2018).

Nevertheless, traditional approaches are known for their limitations, primarily due to their reliance on manual techniques. These procedures are often slow, cumbersome, and incapable of collecting real-time data. This reliance on outdated methods can lead to confusion and incorrect assessments of project infrastructure (Navon & Sacks, 2007; Omar et al., 2018). Consequently, projects may experience delays, cost overruns, and weak communication among stakeholders (Sami Ur Rehman et al., 2023). Such issues result in opacity and a lack of collaboration, leading to miscommunications and misinterpretations among project participants.

Therefore, there is an imminent need to introduce more advanced and efficient progress monitoring systems in the construction industry. By adopting these modern approaches, the construction sector can address the potential challenges and ensure that projects are delivered within the stipulated time, cost, and quality parameters. Enhanced monitoring systems will facilitate better decision-making, improve stakeholder communication, and ultimately lead to more successful project outcomes.

In conclusion, the transition from traditional to advanced project monitoring methods is crucial for the construction industry. Modern technologies offer the potential to overcome the significant challenges associated with outdated practices, enabling projects to be completed more efficiently and effectively. As the industry continues to evolve, embracing these innovations will be essential for achieving sustainable development goals and maintaining competitive advantage in the global market.

1.3 AIMS

This study targets the critical delays prevalent in construction projects within the developing world. Drawing insights from Abeysinghe & Jayathilaka (2022) and the Asian Development Bank (ADB) report on Infrastructure Development in Asia, this research aims to uncover the underlying causes and far-reaching consequences of project delays, particularly concerning cost overruns, disputes, quality issues, and safety risks. The primary objective is to examine the relationship between the successful implementation of progress monitoring and the mitigation of these common challenges, as illustrated by Kopsida & Vela (2015) and Park et al. (2019).

Furthermore, one significant purpose of this study is to evaluate the effectiveness of conventional progress monitoring methods. These traditional approaches, such as manual data collection, paper-based reporting, visual inspections, and site visits, are widely used in the construction industry (Brady et al., 2018; Navon & Sacks, 2007). However, these methods often fall short in providing real-time data and comprehensive oversight. This study will highlight these shortcomings and use them as a foundation for developing incremental solutions that are both technically sound and practical. The goal is to improve the outcomes of on-site assessments and overall project management.

The overarching aim is to develop a fundamental approach to process monitoring systems that enhance transparency, collaboration, and communication among project developers. Improved project stakeholders' communication, as reported by Omar et al. (2018) and Sami Ur Rehman et al. (2023), is crucial for achieving this aim. By

fostering better communication and collaboration, projects can be managed more efficiently, reducing the likelihood of delays and budget overruns.

The study will delve into the various factors contributing to project delays and explore how modern monitoring techniques can address these issues. For instance, real-time data acquisition and advanced project management software can provide up-to-date information, enabling project managers to make informed decisions promptly. These technologies can replace traditional methods, offering more accurate and timely insights into project progress.

Additionally, the research will assess the impact of enhanced monitoring systems on project quality and safety. By providing continuous oversight, these systems can help identify potential issues before they escalate, ensuring that quality standards are maintained and safety risks are minimized. This proactive approach can significantly reduce the incidence of disputes and cost overruns, which are often the result of delayed responses to emerging problems.

Through the attainment of these aims, this research can be considered a feasible attempt to bring about significant changes in project management practices within the construction industry. The study's findings are expected to offer valuable insights into how modern technologies and improved communication strategies can enhance the efficiency and effectiveness of construction projects. By addressing the specific challenges faced by developing regions, this research aims to contribute to more timely project completions and better budget management.

In conclusion, this study aims to bridge the gap between traditional and modern project monitoring methods. By highlighting the deficiencies of conventional approaches and proposing innovative solutions, the research seeks to improve the overall management of construction projects. The ultimate goal is to ensure that projects in the developing world can meet their deadlines and budgets more consistently, thereby enhancing the industry's overall productivity and sustainability. As regions continue to face increasing pressures to deliver infrastructure projects on time and within budget, the insights from this study will be instrumental in guiding future project management practices.

1.4 Project Scope

The primary aim of this project is to address and overcome the prevalent challenges associated with the timely completion of construction projects. This is particularly critical in the developing world, where infrastructure development is often hampered by delays, cost overruns, and various inefficiencies. By developing and implementing a robust and comprehensive progress monitoring system, this project seeks to transform the way construction projects are managed from inception to completion.

1.4.1 Addressing Traditional Monitoring Limitations

Traditional methods of monitoring construction projects, such as manual data collection, paper-based reporting, visual inspections, and frequent site visits, have been widely used for decades. However, these methods are fraught with limitations that impede the timely and efficient completion of projects. Manual data collection is inherently time-consuming and susceptible to human error, leading to inaccuracies that can derail project timelines. Paper-based reporting, while providing a tangible record, is cumbersome to manage and lacks the immediacy required for real-time decision-making. Visual inspections, though necessary, offer subjective assessments that may not fully capture the project’s progress or emerging issues. Site visits, although essential for oversight, are logistically challenging and can be cost-prohibitive, especially for large-scale or remote projects.

1.4.2 Leveraging Modern Technological Advancements

To overcome these limitations, this project will leverage modern technological advancements, integrating them into a comprehensive progress monitoring system. This system will utilize advanced data acquisition technologies, such as sensors, drones, and IoT devices, to collect real-time data on various project parameters, including environmental conditions, equipment status, and construction progress. These technologies will replace manual data collection with automated systems that provide accurate and timely information.

Project management software will play a crucial role in this system, integrating data from multiple sources to offer a cohesive view of the project's status. Real-time dashboards will display up-to-date information, allowing project managers and

stakeholders to monitor progress, identify potential issues, and make informed decisions swiftly. Wireless communication systems will facilitate seamless data transmission and enhance collaboration among team members, ensuring that everyone is on the same page.

Artificial intelligence (AI) and machine learning (ML) algorithms will be employed to analyze the collected data, identify patterns, and predict potential delays or issues before they become critical. These predictive analytics capabilities will enable proactive management, reducing the likelihood of costly delays and overruns.

1.4.3 Improving Efficiency, Accuracy, and Transparency

One of the primary goals of this project is to improve the overall efficiency of construction project management. By automating data collection and integrating advanced analytical tools, the system will significantly reduce the time and effort required to monitor project progress. This will allow project managers to focus on strategic decision-making rather than getting bogged down by manual monitoring tasks.

Accuracy is another critical aspect that this project aims to enhance. The use of sensors, drones, and other automated data collection methods will ensure that the information gathered is precise and reliable. This accurate data will provide a solid foundation for project planning, execution, and monitoring, reducing the risk of errors and ensuring that projects stay on track.

Transparency is essential for fostering trust and collaboration among project stakeholders. The comprehensive progress monitoring system will provide real-time access to project data for all stakeholders, from project managers to contractors and clients. This transparency will facilitate better communication, enabling stakeholders to address issues promptly and work collaboratively towards the successful completion of the project.

1.4.4 Pilot Testing and Feedback Integration

To ensure the system's effectiveness, it will be implemented in several pilot projects. These pilot projects will provide valuable insights into the system's performance in

real-world conditions, highlighting any areas that need refinement. Feedback from these pilot projects will be used to make necessary adjustments, ensuring that the final system is robust, user-friendly, and capable of meeting the diverse needs of construction projects.

1.4.5 Expected Outcomes and Industry Impact

The implementation of this comprehensive progress monitoring system is expected to yield significant benefits. Timely project completion will be facilitated through real-time data and predictive insights, allowing for early identification and mitigation of potential delays. Automated data collection and analysis will reduce the reliance on manual labor, leading to cost savings and minimizing the risk of human error.

Improved quality and safety standards will be achieved through continuous monitoring, which will ensure that quality benchmarks are met and safety risks are promptly addressed. Enhanced stakeholder communication and collaboration will lead to more cohesive project management, fostering a culture of transparency and mutual accountability.

By setting a new standard for project monitoring, this system has the potential to transform the construction industry, particularly in developing regions where traditional methods are still prevalent. The successful implementation of this system will not only benefit individual projects but also contribute to the overall advancement of project management practices, driving efficiency, accuracy, and transparency across the industry.

1.5 Key Objectives:

This project is driven by five key objectives aimed at revolutionizing the management of construction projects through the development and implementation of an advanced progress monitoring system. These objectives are:

1.5.1 Develop a User-Friendly and Cost-Effective Progress Monitoring System:

The primary focus is to design and create a progress monitoring system that is

intuitive, easy to use, and tailored specifically to the unique needs and challenges of construction projects. By prioritizing user experience and cost-effectiveness, the system will be accessible to all stakeholders, regardless of their technical expertise or financial resources.

1.5.2 Implement Real-Time Data Collection Capabilities:

A crucial aspect of the monitoring system is its ability to collect real-time data on various aspects of the construction project. By leveraging modern technology such as sensors, drones, and IoT devices, the system will enable continuous monitoring of progress, resource utilization, and environmental conditions. This real-time data collection will empower project managers to identify potential issues early and take timely corrective actions to keep the project on track.

1.5.3 Integrate Communication and Collaboration Tools:

Effective communication and collaboration are essential for the success of any construction project. To facilitate seamless interaction among project stakeholders, the monitoring system will integrate communication and collaboration tools such as instant messaging, video conferencing, and document sharing. This will ensure that all team members are informed and engaged, leading to better coordination and faster decision-making.

1.5.4 Enhance Transparency and Accountability:

Transparency and accountability are crucial for building trust among project stakeholders and minimizing risks and disputes. The monitoring system will promote transparency by providing all stakeholders with access to real-time project data and progress reports. By fostering a culture of openness and accountability, the system will help mitigate risks and conflicts, ensuring smoother project execution.

1.5.5 Provide Accurate and Up-to-Date Project Progress Reports:

Timely and accurate project progress reporting is essential for informed decision-making and effective project management. The monitoring system will generate comprehensive progress reports based on real-time data, offering insights into project status, milestones achieved, and potential bottlenecks. These reports will enable

project managers to make data-driven decisions and implement timely adjustments to optimize project performance.

By achieving these key objectives, this project aims to transform the management of construction projects, making them more efficient, transparent, and resilient to challenges. Through the development and implementation of an advanced progress monitoring system, construction projects will be better equipped to meet their objectives, deliverables, and deadlines, ultimately leading to improved project outcomes and stakeholder satisfaction.

1.6 Scope of Work

The scope of work for this project encompasses several key activities aimed at developing and implementing an effective progress monitoring system for construction projects. These activities include:

1.6.1 Literature Review and Data Exploration:

The first step involves conducting a thorough review of existing literature and databases to identify factors and gaps in progress tracking within construction projects. This will provide valuable insights into the challenges and opportunities associated with monitoring project progress.

1.6.2 Stakeholder Needs Assessment:

Engage stakeholders through surveys, interviews, and focus group discussions (FGDs) to understand their wants and needs regarding progress tracking. This will ensure that the monitoring system is tailored to meet the requirements of all stakeholders involved in the construction project.

1.6.3 Simulation and Stakeholder Feedback:

Develop simulations of the progress monitoring system and gather feedback from stakeholders to refine and improve the system. This iterative process will help ensure that the system is user-friendly and effectively meets the needs of its users.

1.6.4 Selection of Trial Replicas and Technical Enhancements:

Select trial replicas of the progress monitoring system and implement technical enhancements based on feedback and insights gained from stakeholders. The results obtained from these trials will serve as valuable assets for the project, guiding further development and implementation efforts.

1.6.5 Investigation of Scalability and Interface Compatibility:

Explore reports and case studies to identify scalability issues and interface compatibility with existing management methods. This will ensure that the progress monitoring system can be seamlessly integrated into current project management practices and scaled up to meet the needs of larger audiences.

1.6.6 Training and Equipment Provision:

Provide training and equip staff members with the necessary facilities to effectively utilize the progress monitoring system. This will ensure that staff members are proficient in using the system and can maximize its potential to improve project management efficiency.

1.6.7 Evaluation of System Integration Success:

Evaluate the successful integration of the progress tracking system into construction projects based on criteria such as time, cost, and stakeholder satisfaction. This evaluation will provide insights into the effectiveness of the system and identify areas for further improvement.

1.6.8 Documentation and Reporting:

Conduct and evaluate research findings to properly document the project work, including lessons learned and recommendations for future steps. This will ensure that the project outcomes are effectively communicated to stakeholders and contribute to the body of knowledge in the field of construction project management.

By completing these activities, this project aims to develop and implement a robust progress monitoring system that addresses the needs and challenges of construction

projects. Through stakeholder engagement, technical enhancements, and thorough evaluation, the project will contribute to improved project management practices and ultimately enhance the success of construction projects.

1.7 Deliverables

The deliverables for this project encompass a range of outputs aimed at ensuring the successful development, implementation, and utilization of the progress monitoring system for construction projects. These deliverables include:

1.7.1 **Performance Analysis Report:** A comprehensive analysis report detailing performance metrics, bug and security issues encountered, and the best practices for addressing these issues. This report will serve as a valuable resource for optimizing system performance and ensuring robust security measures are in place.

1.7.2 **Stakeholder Report and Project Requirements Documentation**: A detailed report outlining project stakeholders, their roles and responsibilities, and a comprehensive list of project requirements. Additionally, documentation on existing office space configurations will be provided to inform the design and implementation of the progress monitoring system.

1.7.3 **System Design Validation Mapping**: Validation of the system design will be conducted through mapping of system operations and functionality against operational specifications. This validation process will ensure that the system design aligns with the intended functionality and meets the needs of stakeholders.

1.7.4 **Launch Stage Booklet**: A comprehensive booklet detailing the launch stage of the project, including the design and preparation of the first prototype. This booklet will provide valuable insights into the development process and serve as a guide for future project iterations.

1.7.5 **Training Materials and User Manuals**: The execution phase will involve the development of training materials and user manuals to guide stakeholders in the proper use of the progress monitoring system. These

materials will ensure that users are equipped with the knowledge and skills necessary to effectively utilize the system.

1.7.6 **User Education Program**: A structured user education program will be implemented to provide training for teams involved in the operation and maintenance of the progress monitoring system. This program will cover system operation, requirements, and best practices to ensure optimal system performance.

1.7.7 **Project Achievement Review**: A comprehensive review highlighting the achievements of the project, derived from the overall monitoring system used during project execution. This review will showcase the impact and success of the progress monitoring system in improving project outcomes.

1.7.8 **Project Documentation**: Documentation will include process documentation, lessons learned, and recommendations for future projects. This documentation will serve as a valuable resource for project stakeholders, providing insights into project implementation and offering guidance for future endeavors.

By delivering these comprehensive outputs, this project aims to ensure the successful development, implementation, and utilization of the progress monitoring system, ultimately contributing to improved project management practices and enhanced project outcomes.

CHAPTER 2

LITERATURE REVIEW

2.1 Current State:

Hereafter, The Role of Technology in Construction Progress Monitoring Will Be Explored, therefore.

2.1.1 Introduction to Technological Advancements in Construction Progress Monitoring:

Construction progress monitoring inputs new technological advances: The introduction of technological advancements in construction progress monitoring.

New advanced technologies revised the construction process into a machine called “scanner”, acquiring, and detecting at ultra-high level of qualifying and evaluating maximum data from all sites. Such tools as LIDAR, 3D scanning, digital twins and Augmented Reality (AR) have Increased the capabilities of construction project site-monitoring in which 2-folds the process. Therefore, these devices facilitate data collection which was formerly a complex and inaccurate process but now outcomes are precise.

By using LIDAR technology, a system that is based on lasers for making measurements at once, which allows us to get the 3-D model with a great detail, different angles and in no time. Still, the other method which 3D scanning applies is through creation of geometry of the object or its surroundings with several popular techniques. The models include symmetric damage distribution, occupancy prediction, and evacuation simulation inside a building affected by the impact of the disease. However, digital twins offer the scenario by which to advance and grow the knowledge from analyzing sensor data and simulation models. They facilitate attaining through construction arrangement in the real time where we monitor the process, identify the deviations and optimize them. AR is one of the choices of

technologies used in monitoring where superposition of virtual backdrops on a real visualization space is done to bring about desirable visualization and insights and also assists in the process.

Even though these technological advances in construction have a great potential, the deployment of them is largely hindered because of many barriers encountered. The stakeholders usually hold a line of argument against these innovative measurement tools stating the high cost of acquisition and implementation as well as insufficient expertise among the builders and other construction professionals whilst taking into consideration the advantages that the tools have. On the other hand, the modern way of progress and progress monitoring is labor-intensive, paper-dependent and prone to emailing, which makes communication slow, ineffective and is full of errors, consequently foiling any effort to run an ongoing project.

The issues and limitations outlined above raise a need for putting up an effective mobile application that will be user-friendly and can help to track the progress of a construction project. The adoption of smartphones and tablets as a mobile strategy by mobile apps opens up a lightweight option for monitoring technology beyond the traditional and advanced methods. The perpetual rise of mobile apps in the technology sector has brought with them factors like cost effectiveness, ease of use, and integration with the currently existing workflows. As a result, this makes them a potential solution to monitoring construction projects and providing practical guidance for the different stakeholders.

2.1.2 Resume to the Scientific Detection Tools and Techniques

Recently new devices of data collection and fault finding have been introduced to help strengthen progress tracking in construction projects. These technological innovations embrace LIDAR, 3D scanning, digital twins, and augmented reality (AR) which enhance the infusion of information technology in urban planning.

LIDAR, which originates from Light Detection and Ranging, utilizes laser light pulses as a remote sensor that determines the exact distances, hence, produces geometrically detailed 3D objects and environments (Lohani & Ghosh, 2017). It is

accurate and convenient to call this technology for the purpose of surveying of the construction area and the surrounding regions.

3D scanning involves different methods to record the 3D geometry of the objects or environments, and consequently, 3D models are created digitally (Fetakgidou & Liapis, n. d). This is achieved by the fact that construction experts can obtain multiple in-depth visualizations of all the components of the work site.

Digital twins are real-time virtual replicas of physical projects that involve sensors and simulations monitoring, deviations finding, and efficiency growing (Omrany et al., 2023). This technology helps us mind the project performance and its characteristics across all kinds of possibilities and environments and makes the decision making simple throughout the construction process.

Augmented reality (AR) is a reality generator where the computer vision-computer created images are superimposed on seen real-world environment to overlay pertinent information giving context and enhancing visualization (Wang et al., 201 4). AR is the perfect tool for seeing outside the jobsite, design verification and sharing project information.

These tools for data acquisition and detection ability have demonstrated great advantage in real-time and agile capturing site information, which could help achieve on-time construction supervision to some extent. Although, the realization of these applications on a large scale will require overcoming some obstacles, such as mistrust from stakeholders and the cost of implementation, as well as making these technologies known among contractors and construction professionals.

These technologies also pose different problems that must be tackled.

2.2 Challenges in Adopting Advanced Monitoring Technologies:

Despite the emerging potential of performance management systems to be applied and used in construction progress monitoring, their application is still struggling with many stumbling-blocks. These sources of interference are related to a wide variety of aspects which may prevent them from performing the expected task and release their benefits for an end-user.

2.2.1 Stakeholder Hesitation:

Across from the fact that advanced monitoring devices are not widely accepted among project members is that they do not want to introduce those new technologies into the practice of construction. In many cases, this skepticism is primarily because of the reluctance to change and the preference for old and proven methodologies which they are familiar with.

2.2.2 Financial Barriers:

Advancement in monitoring technologies often requires to invest at high-cost. Getting these technologies tends to be expensive and this coupled with the cost of deploying them can cause a problem for small players whose budgets are not that much.

2.2.3 Lack of Awareness and Understanding:

Being real that the scope of many of the construction professionals can be minimal to having awareness and as well lacks in understanding on the benefits and implementation strategies around the advanced monitoring technologies use. The lack of awareness of these innovative technologies forms a barrier to adoption on the projects.

2.2.4 **Integration Challenges:** The adoption of complex feedback loops and control systems may reduce their ease of implementation or interoperability with ongoing project processes. This would mean the denial of integration complications which are challenges in implementation and would disrupt the existing processes, hence limiting their pace.

2.2.5 **Training and Skill Requirements**: Being able to get the monitoring technologies to work at the needed level will require the building personnel to have the training and skill qualifications. As the workers usually lack the skills to use them correctly, such tools could even be counterproductive on construction sites.

2.2.6 **Compatibility Issues:** As there might be mismatch with existing

hardware, software, or infrastructure that are used in construction projects when the advanced air quality monitoring technologies are introduced, meeting the integration challenge is an essential prerequisite. They can defer the implementation and eventually the total cost in the running of this entire project. Resistance to transformation, provision of sufficient instruction and assistance, and believed gains by the advanced observation technologies in project management of construction are the priorities of this issue. Yet beside these strategies, financial obstacles must be eased and the understanding on the part of the stakeholders must increase with regard to the widespread use of these groundbreaking pieces of equipment as well.

2.2.7 **Financial tracking Barriers:** Regardless of the fact that efficient budget and a cost tracking processes are the key constituents of any successful construction project management, the traditional manual techniques continue to impose certain tangible constraints on the resultant outcome of any respective venture. The paper-based reports as well as budgeting and cost tracking ones, that rely on formulas and form-filling concept are error prone, data centric and impede analysis. Despite the fact that the use of old-fashioned practices will lead the entering of different challenges that range from cost overruns, and even project abortion to the fall, traditional financial tracking methods have various downsides which surpass the mere challenges of data accuracy and availability. They also tend to involve a significant amount of manual handling, taking up so much precious time that it'd be much better spent in other aspects of the company and in the project. Besides no automation and integration with other project processes, it is worth mentioning such challenges leading to the delays of generation of cost overruns and disputes between stakeholders.

In addition to this, the fact that construction projects have multi-stakeholder elements, use a range of resources, and have expenditures involved also increases the need for advanced financial tracking systems. The application of manual methods comes short in this aspect as dynamic construction projects go coupled with a flexible budget, expense account and financial forecasts. This laggy reaction and unresponsiveness can distort the way decisions are taken, compromising the whole project

implementation. Briefly, the reliance on the classic approach of financial tracking methods faces the barriers of strategic management of a construction project. These barriers cover up a range of problems comprising errors, inaccessible data in real time, ineffective analysis, manual processing of data, and the impossibility of integrating this IT process with other project management tools. Overcoming these obstacles needs the utilization of more modern and user-friendly tracking tools, the proposed mobile application, for example, whose role would be to help quick and well-informed decision making and boost project success. 2. 4 Importance of Effective Communication and Document Management: The communication process, along with the documents management, are two important bases for construction project management. Apart from monitoring progress, the essence of these components is to enhance efficiency optimally, contain costs, and create success for the project itself. Besides, traditional methods of communication and documents management, such as paper documents and emails not only take a long time and affect efficiency but also get issues about version controlled. Such, it might result in the lack of good communication among project stakeholders, which ultimately leads to expenditure overruns, time overruns, disputes and even project failure. Furthermore, carrying heavy binders, files and bulkier drawings at construction sites to work in and use them might lower the efficiency and comfort of the workers, which constitutes an extra cost to the project. As the case presently stands, conventional approaches do not supplant the agility and user -friendliness needed in the contemporary project management architecture of construction practices.

Consequently, legible communication and accurate document management are two key factors which allow the completion of projects without any problem among partners and on time. By using digital tools and platforms the authorities of the construction come to know their weak sides and take action to enhance transparency, reduce errors and increase productivity throughout the project life cycle.

Consequently, the efficient optimization of construction progress monitoring systems could be possible via integration into the communication and document management system, which will certainly supersede the shackles of the old-clawing method. Therefore, it can be concluded that this way of communication improves and provides everyone with the latest information, allowing timely and informed decision-making in construction projects.

2.3 Advantages Over Advanced Monitoring Technologies:

The proposed mobile app for construction progress monitoring offers several advantages over advanced monitoring technologies currently used in the construction sector. These advantages contribute to its suitability and effectiveness in enhancing project monitoring and control. Here's a detailed exploration of the advantages:

2.3.1 Accessibility and Convenience:

- **Utilization of Existing Devices**: Individuals and companies involved in construction projects commonly possess smartphones and tablets. The mobile app leverages this widespread ownership, eliminating the need for investment in expensive specialized monitoring devices.
- **Anytime, Anywhere Monitoring**: With the mobile app, users can monitor project progress from anywhere at any time. This accessibility promotes inclusivity and collaboration among project team members, facilitating a more cohesive working environment.

2.3.2 Cost Effectiveness:

- **Affordability and Elimination of Financial Barriers**: Unlike advanced monitoring technologies that require significant investment in purchasing and installation, mobile apps can be downloaded for free or at a reasonable price. This affordability reduces financial barriers, particularly for smaller projects or those operating with limited budgets.

2.3.3 User-Friendly Interface:

- **Ease of Use**: The mobile app's friendly user interface enhances its acceptance among construction professionals. Minimal training is required, allowing the construction team to quickly adapt and incorporate the app into their workflow. This ease of use contributes to faster adoption and utilization compared to complex monitoring systems.

2.3.4 Integration Potential:

- **Interoperability and Seamless Integration**: The mobile app is designed to seamlessly integrate with existing infrastructure and activities. This interoperability resolves implementation challenges and facilitates the transition to digital solutions. By aligning with current operations, the app enhances efficiency and minimizes disruption to established workflows.

2.3.5 Speed of Implementation:

- **Rapid Deployment and Minimal Downtime**: The mobile app offers a swift implementation process, ensuring minimal downtime and enabling immediate access to monitoring capabilities. Its quick deployment addresses the urgency of project monitoring needs, enhancing overall project efficiency and productivity.

In summary, user-friendly mobile applications for construction progress monitoring provide significant value through their accessibility, cost-effectiveness, ease of use, and integration potential. These advantages effectively overcome the limitations associated with advanced monitoring technologies, making them a practical and efficient solution for enhancing project monitoring and control in the construction sector.

CHAPTER 3

RESEARCH METHODOLOGY

3.1 Introduction to Research Methodology:

The systematic approach and methodology embraced in this study are meticulously crafted to conceptualize, design, and implement a cutting-edge mobile application primed for seamless management of construction projects. This methodology, meticulously designed and structured, comprises a series of well-defined stages aimed at orchestrating the development of a user-friendly, robust mobile application capable of efficiently navigating the complexities inherent in construction project management.

At the forefront of this methodology is an exhaustive review of literature sources spanning the realms of construction project management and mobile application development. This comprehensive exploration serves as the bedrock upon which the subsequent stages are built, providing invaluable insights into prevailing practices, challenges, and breakthroughs in both domains. By meticulously scrutinizing existing research, publications, and industry reports, the study acquires a nuanced understanding of the landscape, thus laying a solid foundation for informed decision-making in the development process.

Following the comprehensive literature review, the methodology pivots towards the design phase, wherein the mobile application takes shape. Central to this stage is the integration of key modules aimed at preventing drunk driving, a critical consideration in the construction project milieu. These modules, meticulously curated and seamlessly integrated into the application's architecture, serve as proactive measures to enhance safety and compliance within construction project environments. By incorporating features specifically tailored to mitigate the risks associated with alcohol-impaired driving, the mobile application not only streamlines project management but also fosters a culture of safety and responsibility among construction personnel.

Moreover, a user-centered design approach underpins every facet of the development process, ensuring that the mobile application resonates with the needs and preferences of its intended users. Through iterative cycles of feedback gathering, usability testing, and design refinement, the application evolves organically, iteratively honing its usability, functionality, and overall user experience. By placing the end user at the forefront of the design process, the study endeavors to create an intuitive, user-friendly platform that empowers construction project managers, workers, and stakeholders alike.

In essence, the systematic methodology delineated herein represents a holistic and meticulously orchestrated framework for the development of a transformative mobile application tailored for construction project management. By leveraging the insights gleaned from a comprehensive literature review, integrating modules to prevent drunk driving, and adopting a user-centered design approach, the study endeavors to forge a paradigm shift in the way construction projects are managed and executed.

3.2 Literature Review of Present Solutions:

The research embarked on its journey by undertaking a comprehensive review of the literature pertaining to construction project management and tracking, delving deep into the wealth of knowledge already available in these domains. This exhaustive review served as the cornerstone of the research endeavor, aimed at illuminating both the strengths and weaknesses inherent in the traditional methodologies and contemporary technologies employed within the construction industry. By meticulously dissecting the literature landscape, the research endeavored to gain a nuanced understanding of the prevailing practices and emerging trends shaping the field of construction project management.

Central to this review was the identification and analysis of the key challenges confronting construction project managers and stakeholders. By meticulously scrutinizing the literature, the research sought to shed light on the myriad obstacles and pain points encountered in the execution of construction projects, ranging from budget overruns and scheduling delays to communication breakdowns and safety concerns. Moreover, the review aimed to elucidate the existing solutions and

strategies devised to address these challenges, providing valuable insights into the arsenal of tools and techniques available to project managers.

Armed with a comprehensive understanding of the landscape, the research set out to develop a mobile application tailored to the unique needs and exigencies of the construction industry. Drawing upon the insights gleaned from the literature review, the mobile app was conceptualized and designed to serve as a multifaceted solution capable of addressing the identified challenges head-on. By leveraging the awareness garnered from the review process, the research aimed to develop a mobile application that not only mitigates the shortcomings of traditional methodologies but also harnesses the potential of contemporary technologies to drive innovation and efficiency in construction project management.

In essence, the literature review served as a springboard for the development of the mobile application, providing the research with a solid foundation upon which to build its innovative solution. By meticulously documenting the strengths, weaknesses, opportunities, and threats inherent in the current landscape, the review process laid the groundwork for the subsequent phases of research and development, ensuring that the mobile app is finely attuned to the needs and realities of the construction industry.

3.3 Development of Mobile Application with Four Modules:

To harness the insights gleaned from the extensive literature review, the mobile application was meticulously structured and designed to optimize functionality across four key components, strategically engineered to address the inherent challenges and shortcomings identified within the construction industry. These modules were thoughtfully crafted to serve as dynamic solutions tailored to the diverse needs of construction project management, each offering a suite of functionalities aimed at enhancing efficiency, collaboration, and communication among stakeholders.

3.3.1 **Work-Progress Monitoring Module:** At the core of the mobile application lies a robust work-progress monitoring module, designed to provide real- time insights into the status of construction projects. This module empowers project managers to track milestones, identify

bottlenecks, and monitor

progress against predetermined timelines. By offering granular visibility into project activities, this module facilitates proactive decision-making and enables timely interventions to mitigate delays and optimize project outcomes.

3.3.2 **Documents Management and Sharing Module**: Complementing the work-progress monitoring module is a comprehensive documents management and sharing module, engineered to streamline the storage, organization, and dissemination of critical project documentation. From blueprints and permits to contracts and invoices, this module offers a centralized repository for all project-related documents, ensuring easy access and collaboration among stakeholders. With robust sharing capabilities, stakeholders can seamlessly exchange documents, fostering transparency and efficiency in project communication.

3.3.3 **Financing Module**: Recognizing the paramount importance of financial management in construction projects, the mobile application features a dedicated financing module. This module equips project managers with tools for budget tracking, expense management, and financial reporting, enabling them to maintain fiscal discipline and accountability throughout the project lifecycle. By providing real-time insights into project finances, this module empowers stakeholders to make informed decisions and allocate resources judiciously, thereby minimizing cost overruns and maximizing project profitability.

3.3.4 **Chat Feature for Seamless Communication**: Facilitating seamless communication among stakeholders is a dedicated chat feature integrated into the mobile application. This feature enables project teams to engage in real-time discussions, share updates, and collaborate on tasks, fostering a culture of transparency and teamwork. By providing a centralized platform for communication, this feature enhances coordination and cohesion among project participants, driving productivity and synergy across the project ecosystem.

Each module within the mobile application was meticulously crafted to address the most distinctive requirements and pain points identified through the literature review process. By prioritizing collaboration, communication, and decision-making, the

mobile application seeks to revolutionize construction project management, empowering stakeholders to navigate challenges effectively and achieve project success.

3.4 User-Centered Design Approach:

The User-Centered design approach lies at the heart of the entire project, guiding every stage of the creation process with a keen focus on meeting the needs and preferences of the diverse range of stakeholders involved. This user-driven strategy ensures that the mobile application is tailored to the specific requirements of consultants, engineers, managers, clients, and other key stakeholders within the construction industry ecosystem. By placing the user at the center of the design process, the aim is to deliver a user interface that is intuitive, seamless, and reflective of industry best practices.

Throughout the design process, extensive efforts were made to gather insights and feedback directly from end-users, ensuring that their voices and perspectives are integrated into every aspect of the application's interface and functionality. By actively soliciting input from stakeholders at all levels, from consultants and engineers to managers and clients, the design team gained invaluable insights into the unique needs, preferences, and pain points of each user group.

Armed with this user-centric approach, the design team endeavored to create a user interface that is both intuitive and simple, mirroring established industry practices while prioritizing user satisfaction and ease of use. By leveraging industry-standard design principles and incorporating user feedback into the iterative design process, the aim is to deliver a mobile application that not only meets the functional requirements of construction project management but also delights users with its usability and efficiency.

In essence, the User-Centered design approach serves as the guiding principle for the entire project, ensuring that the mobile application is finely tuned to the needs and

preferences of its end-users. By placing a strong emphasis on user feedback, usability testing, and iterative design refinement, the goal is to create a user interface that fosters high levels of user satisfaction and enhances overall usability, ultimately driving adoption and success within the construction industry.

3.5 Figma Prototype Development:

During the design phase, a prototype of the mobile application was meticulously crafted using the detailed Figma design tool. This prototype served as a visual representation of the app interface and its functionalities, offering stakeholders a tangible preview of the product in development. Through a collaborative effort between producers and designers, the prototype was subjected to rigorous testing and iteration, with feedback collected and incorporated into subsequent design iterations.

The development of the prototype was guided by the chosen programming language, ensuring that it closely emulated the intended user experience and workflows of the final product. By leveraging accepted programming standards and best practices, the prototype aimed to provide stakeholders with a realistic and immersive preview of the mobile application's functionality and features.

Throughout the testing process, stakeholders were actively encouraged to provide constructive criticism and suggestions, enabling the design team to refine and enhance the prototype iteratively. This iterative feedback loop facilitated continuous improvement and optimization of the app's design, ensuring that it aligns closely with user expectations and preferences.

In essence, the development of the prototype marked a crucial milestone in the design process, offering stakeholders a firsthand glimpse into the future of the mobile application. By harnessing the power of Figma and adhering to industry-standard programming practices, the prototype provided a robust foundation for further refinement and development, paving the way for the creation of a user-friendly and intuitive mobile application tailored to the needs of the construction industry.

3.6 Feedback Incorporation from Field Experts:

To ensure that the mobile application meets the specific needs and requirements of construction professionals and project managers, a controls prototype was meticulously developed and showcased to field experts using the Figma platform. This prototype served as a tangible representation of the app's interface and functionality, allowing experts to interact with key features and provide valuable feedback for validation.

The demonstration of the controls prototype to field experts was conducted with careful consideration for their expertise and insights. By soliciting feedback from individuals with firsthand experience in construction project management, the design team gained invaluable insights into the usability, functionality, and overall user experience of the app. This feedback-oriented approach enabled designers to incorporate expert input into subsequent design iterations, ensuring that the final solution is tailored to the specific needs and preferences of its intended users.

Throughout this iterative process, designers actively engaged with field experts to translate their thoughts and suggestions into actionable design improvements. By prioritizing the incorporation of expert feedback, the design team ensured that the mobile application would effectively cater to the desires and expectations of clients and end-users within the construction industry.

The experiential feedback-oriented loop formed the cornerstone of the design process, driving continuous refinement and enhancement of the app's design, functionality, and user experience. By iteratively addressing expert feedback and validation, the design team was able to iteratively decrease design friction and enhance the overall usability and effectiveness of the app.

In essence, the demonstration and validation of the controls prototype with field experts played a pivotal role in shaping the development of the mobile application. By leveraging their expertise and insights, designers were able to create a solution that is

not only aligned with industry best practices but also tailored to the specific needs and preferences of its target audience.

3.7 Iterative Development Process:

The design and development processes of the mobile application were meticulously executed through an iterative approach, characterized by continuous refinement, revision, and feedback incorporation. At each stage of the process, the design team engaged in thorough evaluation and testing to ensure that the app met the highest standards of user-friendliness, functionality, and operational smoothness, specifically tailored to the unique requirements of construction project management.

Throughout the iterative cycle, the design team embraced a mindset of flexibility and adaptability, readily revising and refining design elements as needed. This iterative approach allowed for the identification and resolution of any potential issues or shortcomings early in the development process, minimizing the need for extensive redesigns and mitigating the risk of overlooking crucial functionality.

Central to this iterative approach was the continuous solicitation of feedback from stakeholders, including construction professionals, project managers, and end-users. By actively engaging with these stakeholders and incorporating their perspectives and insights into the design process, the team was able to ensure that the app's features and functionalities aligned closely with the specific needs and expectations of its intended audience.

Moreover, rigorous testing and evaluation were conducted at each iteration to assess the app's performance, usability, and overall user experience. By subjecting the app to real-world usage scenarios and user interactions, the team gained valuable insights into areas for improvement and refinement, enabling them to fine-tune the app's design and functionality to perfection.

In essence, the iterative approach adopted in the design and development processes of

the mobile application allowed for continual improvement and optimization, ultimately resulting in a product that excels in user-friendliness, functionality, and effectiveness within the context of construction project management. Through constant feedback and testing, the team was able to deliver a solution that meets the specialized specifications and requirements of the construction industry, setting a new standard for excellence in project management software.

3.8 Application Development:

Prior to the commencement of mobile application development, a crucial design phase was initiated to ascertain the functionality and aesthetics of the application. Leveraging the Flutter framework and Dart language, this design phase laid the groundwork for the creation of a robust and visually appealing cross-platform app. Flutter's versatility and Dart's flexibility enabled the design team to seamlessly integrate graphic elements and code, resulting in an application that is both feature-rich and performance-driven.

One of the key advantages of utilizing Flutter for app development is its ability to deliver a native-like experience across multiple platforms. By leveraging Flutter's widget-based architecture, the application's performance and interface exhibit native characteristics, ensuring a consistent user experience across various devices and operating systems. This uniformity in user experience enhances usability and accessibility, regardless of the device or platform used.

Furthermore, the application is hosted on a secure cloud-based platform, ensuring efficient communication and collaborative work among stakeholders while prioritizing the privacy and security of data. This cloud-based infrastructure enables seamless access to project information and facilitates real-time collaboration among team members, regardless of their location or device. By implementing robust security measures, such as encryption and access controls, the application safeguards sensitive project data and mitigates the risk of unauthorized access or data breaches.

In summary, the design phase of the mobile application, powered by Flutter and Dart, laid the foundation for a high-performance, visually appealing, and secure cross-platform app. Through careful consideration of functionality, aesthetics, and security, the application is poised to revolutionize project management in the construction industry, fostering efficient communication, collaboration, and data privacy among stakeholders.

3.9 Utilization of Flutter Framework and Dart Language:

The decision to utilize Flutter and Dart for our mobile application development was rooted in a strategic assessment of their respective advantages and capabilities. Flutter, renowned for its superior performance, efficiency, and cross-platform compatibility, emerged as the ideal framework to meet our project requirements. Its innovative principles, designed around rapid prototyping and development, enabled our team to expedite the creation process and iterate over project resources with ease. This streamlined approach not only accelerated development timelines but also facilitated seamless collaboration and innovation throughout the project lifecycle.

Complementing Flutter's strengths, Dart emerged as a powerful and scalable language perfectly suited for building complex mobile applications. Its robust features and versatile syntax provided the foundation for developing sophisticated features and functionalities within our application. By harnessing Dart's capabilities, we were able to implement intricate business logic and seamlessly integrate advanced features, enhancing the overall functionality and usability of the application.

The synergy between Flutter and Dart culminated in the delivery of a high-level and user-friendly application dedicated to construction project administration. By leveraging the performance, efficiency, and cross-platform capabilities of Flutter, coupled with the power and scalability of Dart, we were able to develop a cutting-edge solution that meets the diverse needs and requirements of construction project management. From rapid prototyping to seamless collaboration, Flutter and Dart played pivotal roles in driving the success of our project, delivering a solution that sets new standards for excellence in the industry.

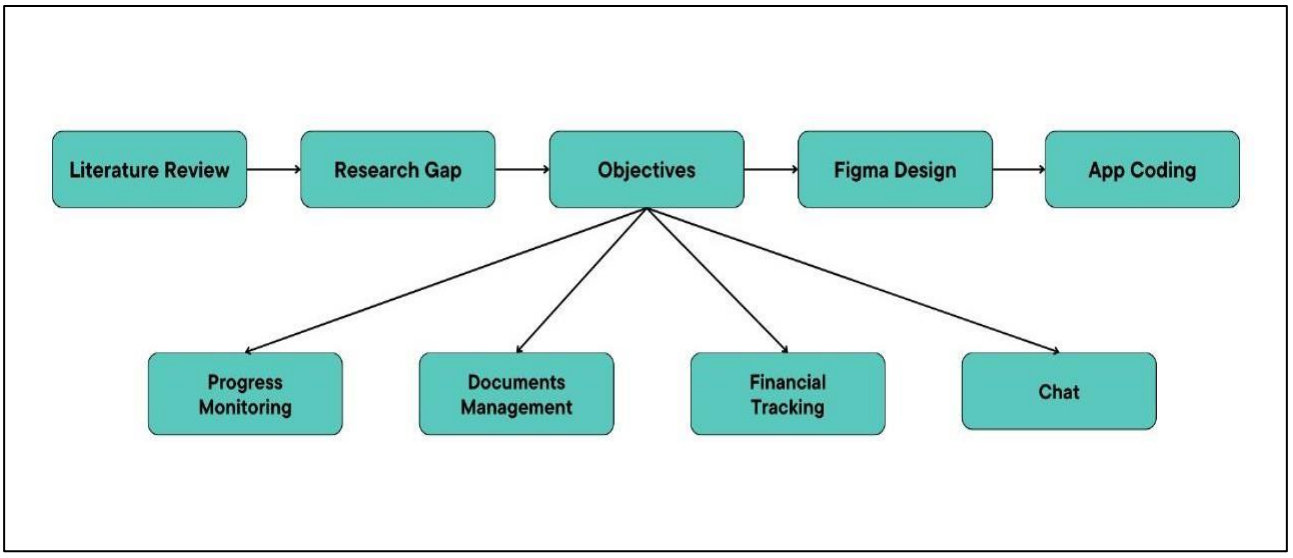


Figure 1: Methodology workflow diagram.

3.10 Secure Cloud-Based Platform for Stakeholder Collaboration:

The migration of the application to a secure cloud-based platform represented a strategic decision aimed at enhancing collaboration and accessibility for all stakeholders involved in construction projects. By leveraging this digital platform, the application served as a centralized repository for project data and documents, offering stakeholders unparalleled convenience and flexibility in accessing critical information.

With the app hosted on a cloud-based platform, stakeholders gained the ability to access project data from any location at any time, eliminating geographical barriers and enabling seamless collaboration across distributed teams. This accessibility fostered a more agile and efficient workflow, empowering stakeholders to make informed decisions and take timely actions, regardless of their physical location.

Moreover, the adoption of a cloud-based system provided an additional layer of security and privacy for the app's data. By leveraging advanced encryption and access control mechanisms, the app ensured that sensitive project information remained protected against unauthorized access or data breaches. This enhanced security framework instilled confidence among stakeholders, fostering trust and reliability in the platform.

In summary, the migration to a protected cloud-based platform represented a strategic

move to enhance cooperation, communication, and collaboration among stakeholders in construction projects. By offering convenient access to project data and documents from any location, while ensuring robust security and privacy measures, the app empowered stakeholders to work more effectively and efficiently towards project success.

3.11 Specific Project Roles and Approval Process:

The mobile application, developed under the umbrella of mobile technology, was meticulously designed to cater to the diverse needs and roles of individuals involved in construction projects. Targeting a wide spectrum of stakeholders including consultants, engineers, contractors, and clients, the application was tailored to accommodate the unique requirements and responsibilities of each role.

To ensure seamless functionality and usability, we implemented a role-based access control system within the application. Each user was assigned a specific role that determined their level of access to various features and functionalities. This role-based approach enabled us to apply security measures and grant appropriate permissions and access rights to users based on their designated roles and responsibilities.

For instance, consultants and engineers may require access to technical specifications and project documentation, while contractors may need access to scheduling and resource allocation tools. Similarly, clients may require access to project progress reports and financial information. By assigning distinct roles and permissions to each user, we ensured that individuals had access to the information and tools necessary to carry out their respective tasks effectively and efficiently.

Furthermore, we implemented stringent security measures to safeguard sensitive project data and information. This included encryption protocols, multi-factor authentication, and regular security audits to mitigate the risk of unauthorized access or data breaches.

In essence, the role-based access control system implemented within the mobile application ensured that each stakeholder had the appropriate level of access and permissions tailored to their specific role and responsibilities. By prioritizing security and usability, we created a robust and user-friendly platform that empowered individuals from different roles to collaborate effectively and contribute towards the success of construction projects.

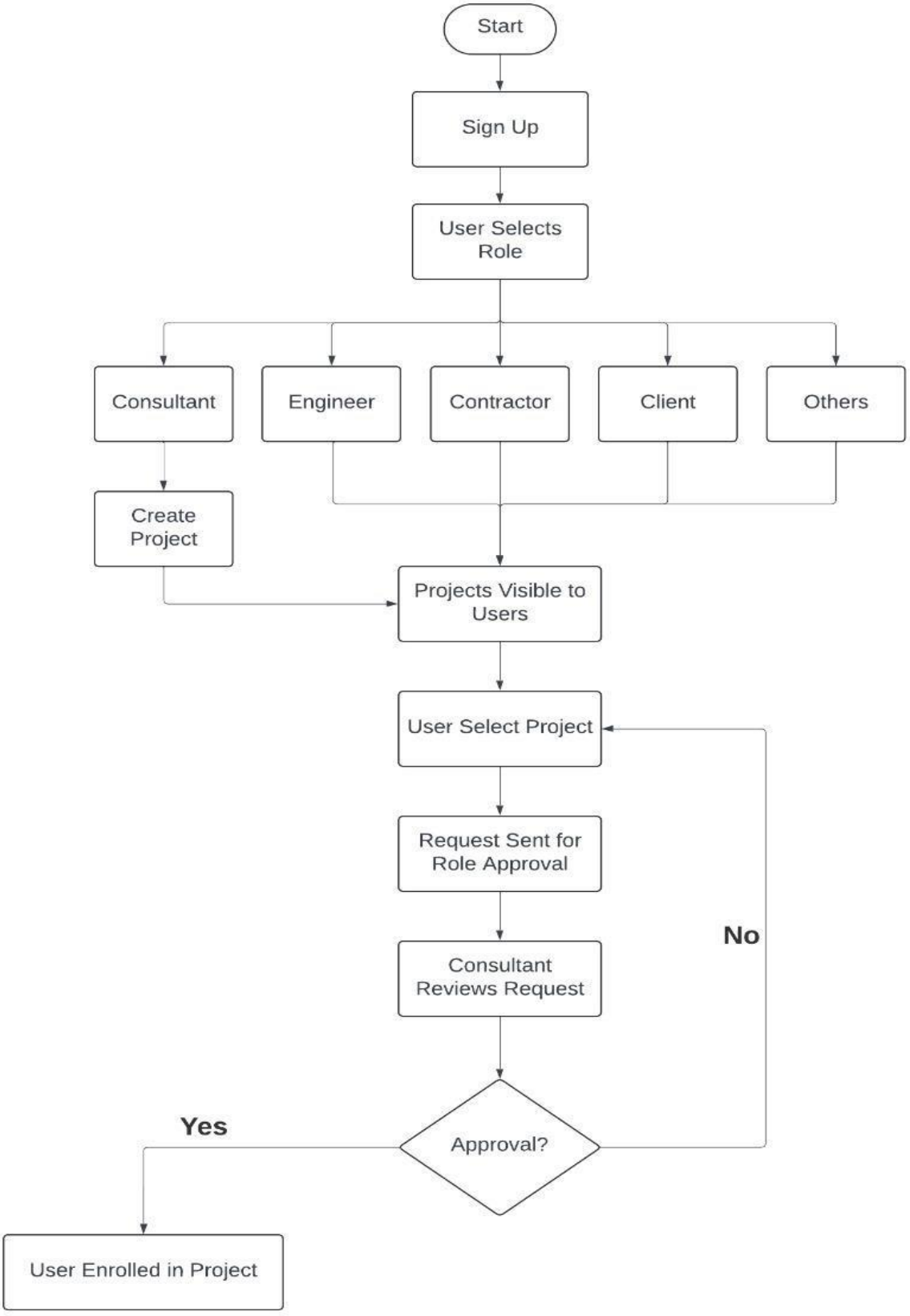


FIGURE 2: FLOW DIAGRAM OF ROLE APPROVALS

CHAPTER 4

Module Descriptions:

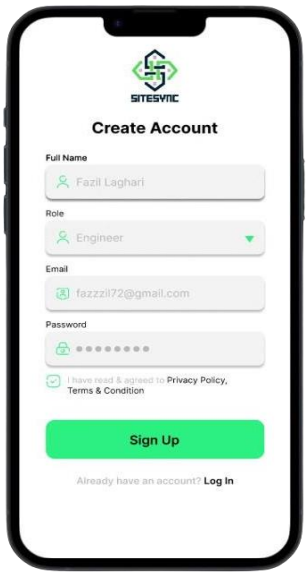
4.1 Progress Monitoring

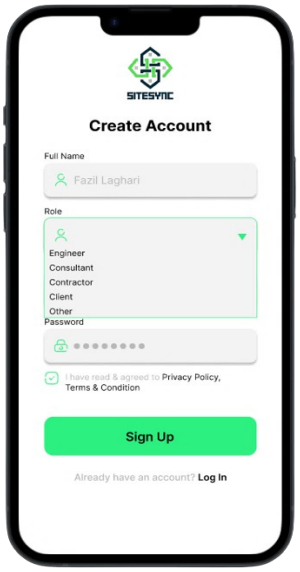
The staff engineer adds up the tasks schedule on a Microsoft Excel sheet. The app reads three specific columns: <name of the activity>, from date to date. Thereafter, it builds personal sections where each of these tasks has its name, its date of beginning and its date of completion highlighted and displayed in an absorbable data chart. This allows tracking the timeline and ensuring that all key actors are aware of the deadlines and the project flow.

This app's agenda part permits editing, delete and create activities chronologically. In fact, most of such work will involve amending start and finishing dates, changing the order of execution, as well as renaming activities. After that, the new schedule gets exported in various formats, like. csv and. pdf or data that can be easily applied to other software that don't need further manual changes which is a very technical process. The example-triggered interface, through which you can update schedules and, perhaps, cut down the costs related to additional software incense and consequently streamline the project process for stakeholders.

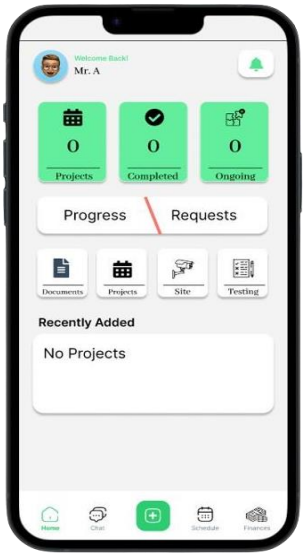
The engineer can take pictures onsite of the progress work and upload that pictures under the appropriate activity tab within the app. Photos can be cataloged in albums directly from a phone's memory or photos can be captured on phone and uploaded to the cloud. The application requires users to take photos and click on the 'Relevant Event' button to identify which activity each captured picture is related to. Posting a photo is a great way to share visual evidence of progress with everyone, thus maximizing efficiency, transparency and reducing the need for subjective assessments.

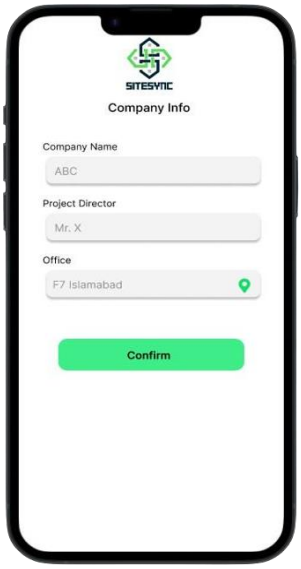
SITESYNC is the name of our app. Sign up for a new account on the platform by providing necessary information like email and password. Select the role or position you will have within the platform (e.g., project manager, consultant).

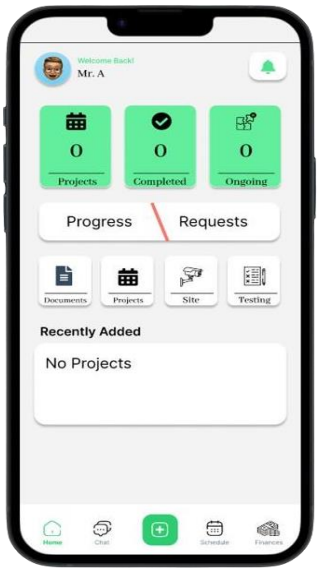




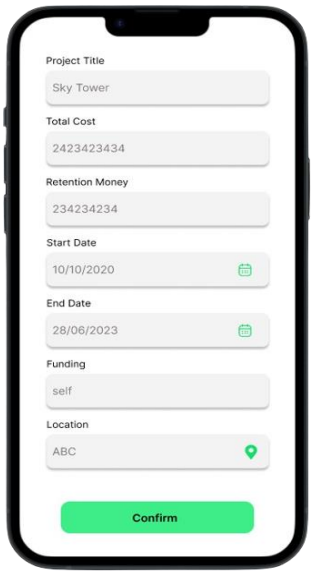
Provide details about your company, such as its name, address, and contact information. Confirmation that your new account has been successfully set up.

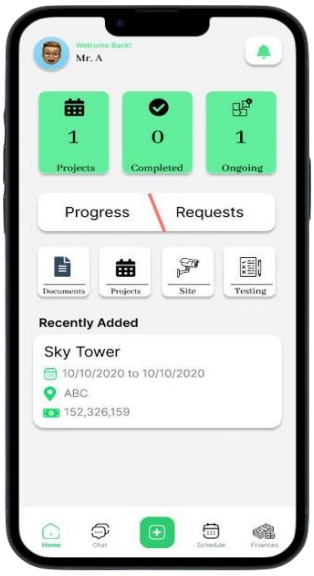


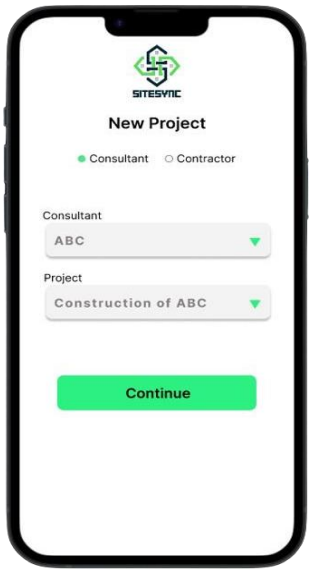




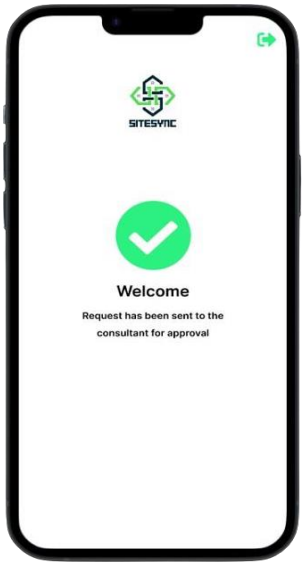
Start a new project by entering project-specific details like the project name and description. Notification that your project has been successfully set up. Select the consultancy firm you are working with and assign them to the project.

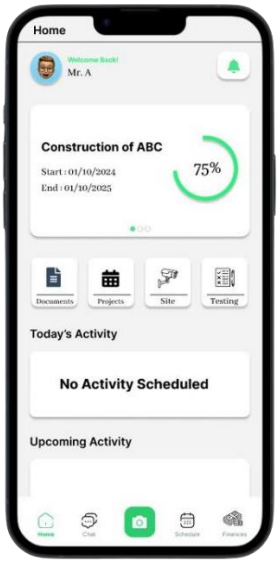




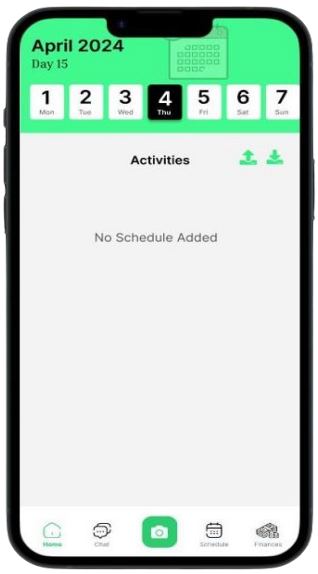


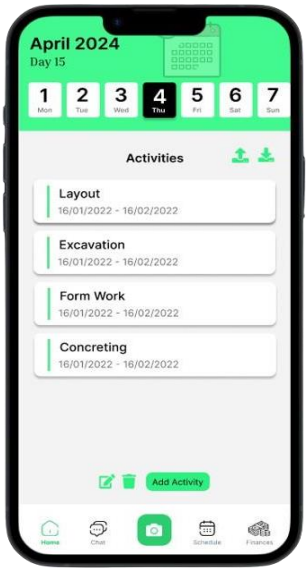
A request is submitted to approve the role you have selected within the project. A request is submitted to approve the role you have selected within the project. Confirmation that your role within the project has been approved. You are now officially part of the project team.

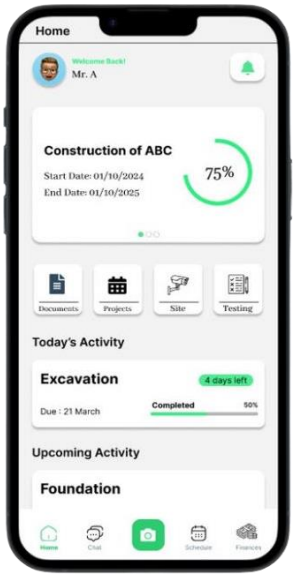




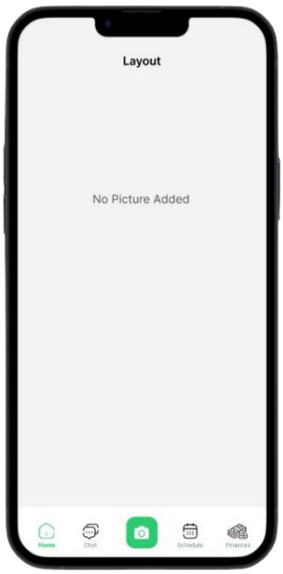
Add the project timeline and milestones to the platform. Once the schedule is uploaded, all project activities and tasks will be visible on the platform. Each activity within the project has relevant pictures associated with it to provide visual context or evidence of progress.

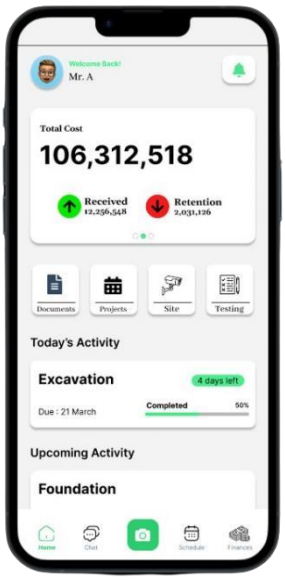




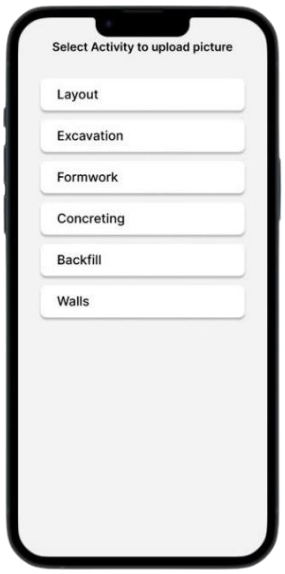


Updates on the status and advancement of work and specific project activities. An overview of financial data related to the project, including budgets, expenditures, and financial progress. Information about the current weather conditions which may affect the project.

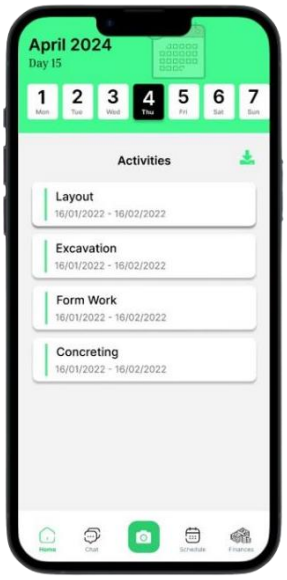




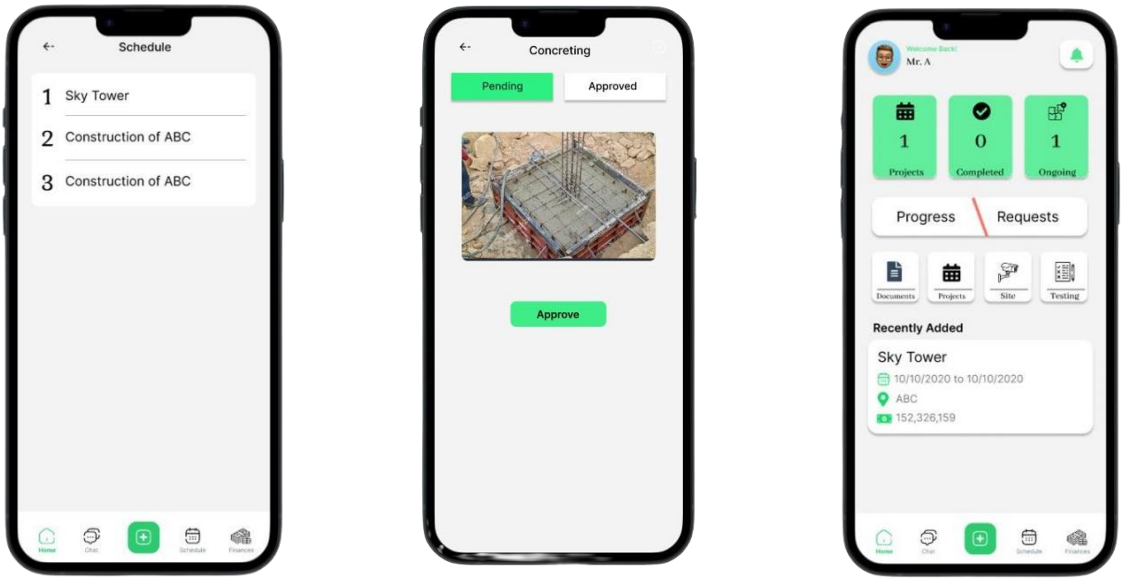
Capture a new photo or upload an existing one to the platform. Verify and approve the picture or information before it is uploaded or shared. Attach the picture or document to the specific activity it is related to within the project.



Confirmation that the picture has been successfully uploaded to the platform. The uploaded picture or information can be viewed by all authorized users of the platform. Choose the specific project you are working on from a list of projects. Confirmation that the project timeline and schedule have been successfully uploaded.



Reiteration that the picture is now available within the selected project and activity.



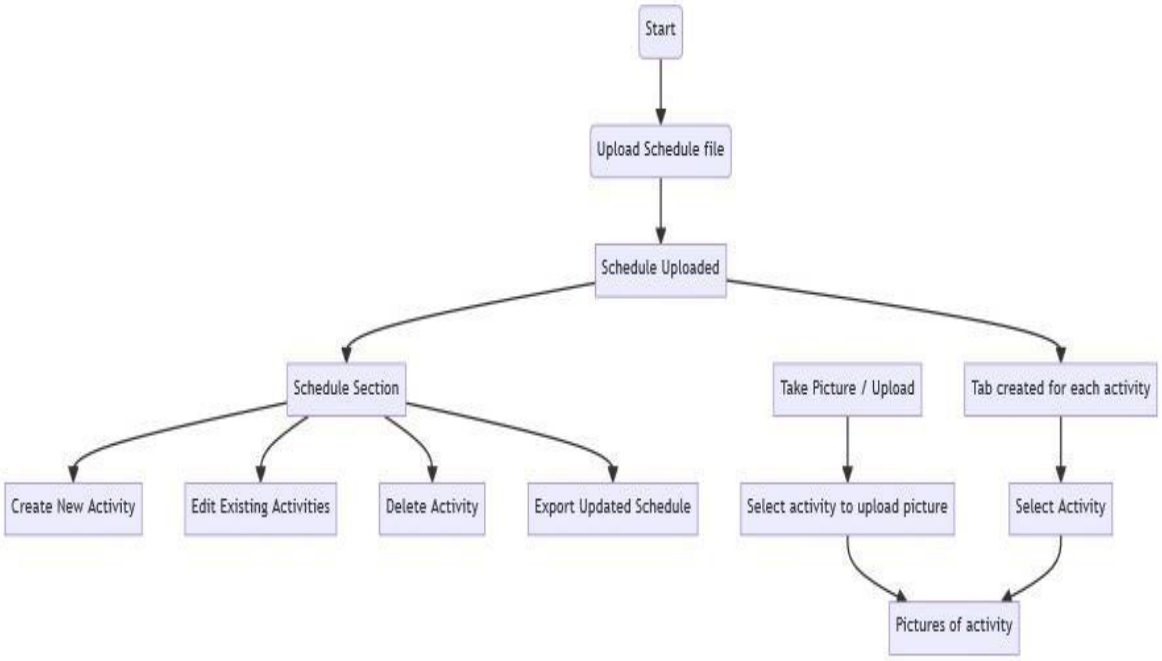


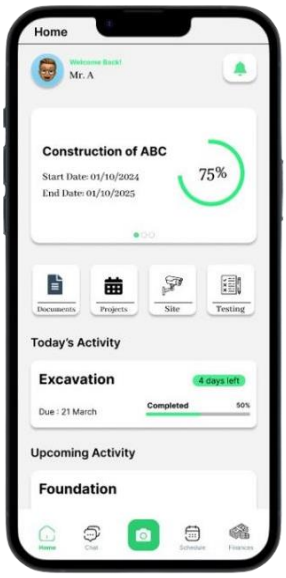
FIGURE 3: WORKING OF MODULE 1

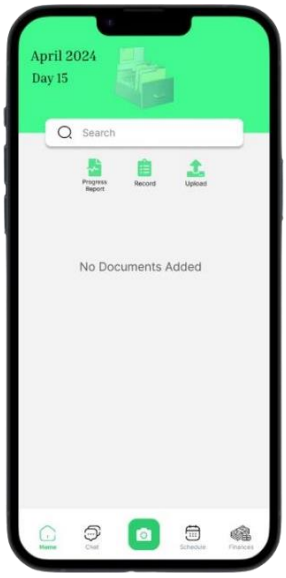
4.2 Documents Management:

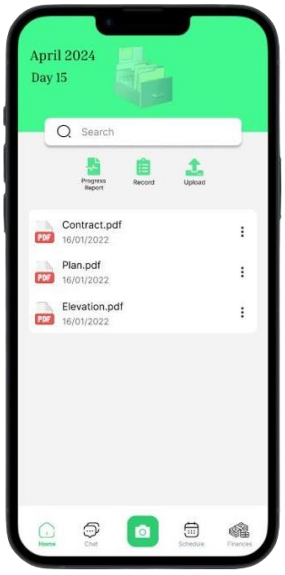
The engineer, advisor, and engineer contractor can add items, contracts, drawings, progress, and test reports. All files are uploaded to the central depository so that everyone - customers as well as the project team can get information. Through the app, a central data register is created providing for an increased alliance and demands for the presence of the necessary data is posed which allows faster response time to question of crisis.

Utilizing the project schedule through calculating progress reports, the app automatically creates a daily report which not only includes the planned task for the day but also include details on what has been done and the progress accomplished to date. An app used has three features including the app name, project stakeholders and their details. Also, this report will be done are editable as per customer's need and then they will receive as Pdf file. This inclusive coverage gets rid of manual report creation process which becomes a great time-saver and a real paperwork reduced.

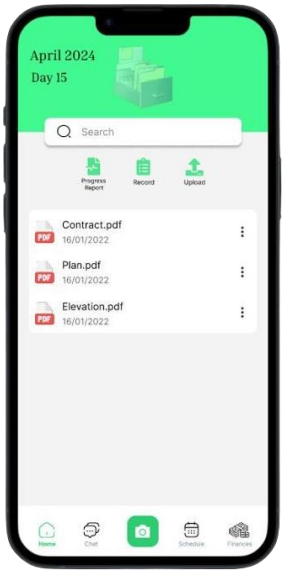
Navigate to the "Documents" section of the platform. Indicates that there are currently no documents available in this section. Add new documents to the platform by uploading them from your device.

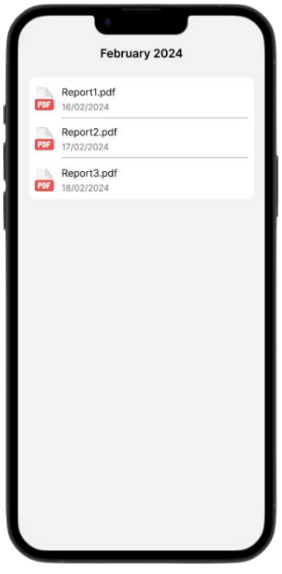




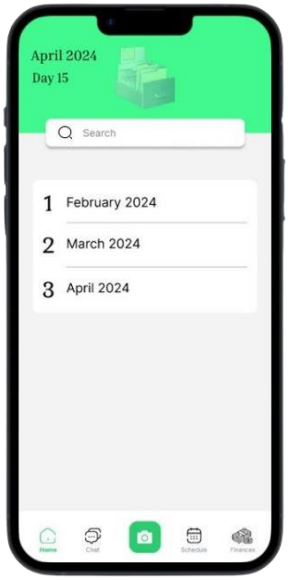


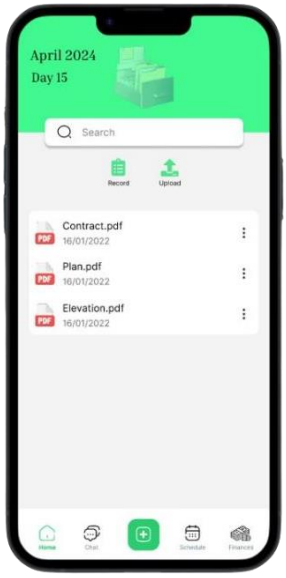
Access the "Progress Report" section within the documents area. Open the specific "Report" section to view detailed reports. Choose a specific month to view reports related to that period.

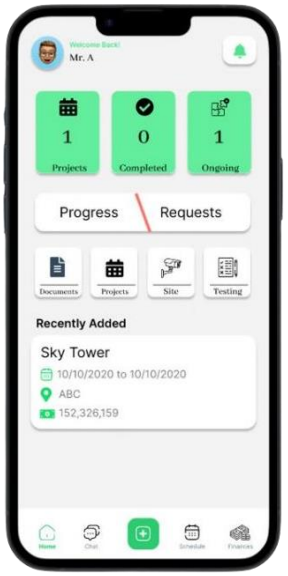




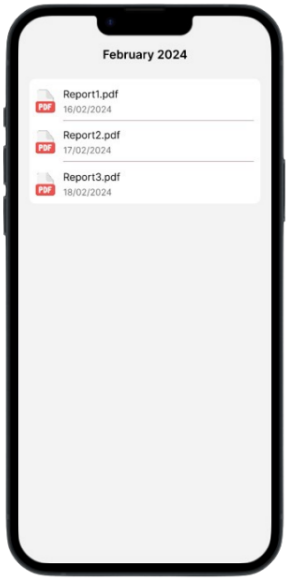
The selected month’s section includes all reports generated during that month. These reports are available for viewing by all authorized users on the platform. Navigate to the overall "Report" section, where various reports are stored.

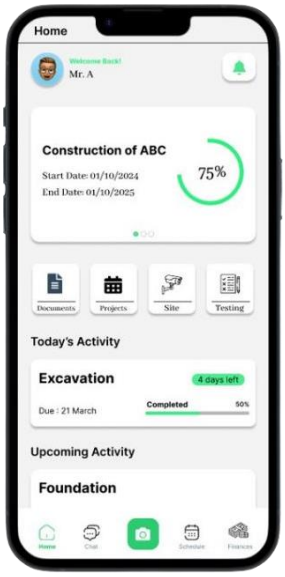


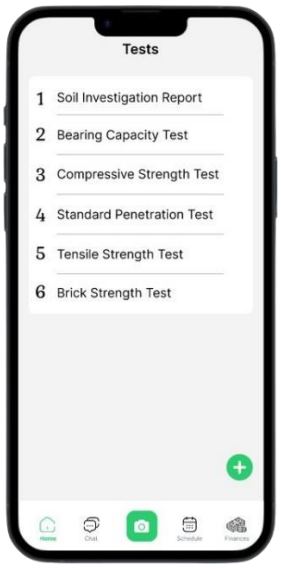




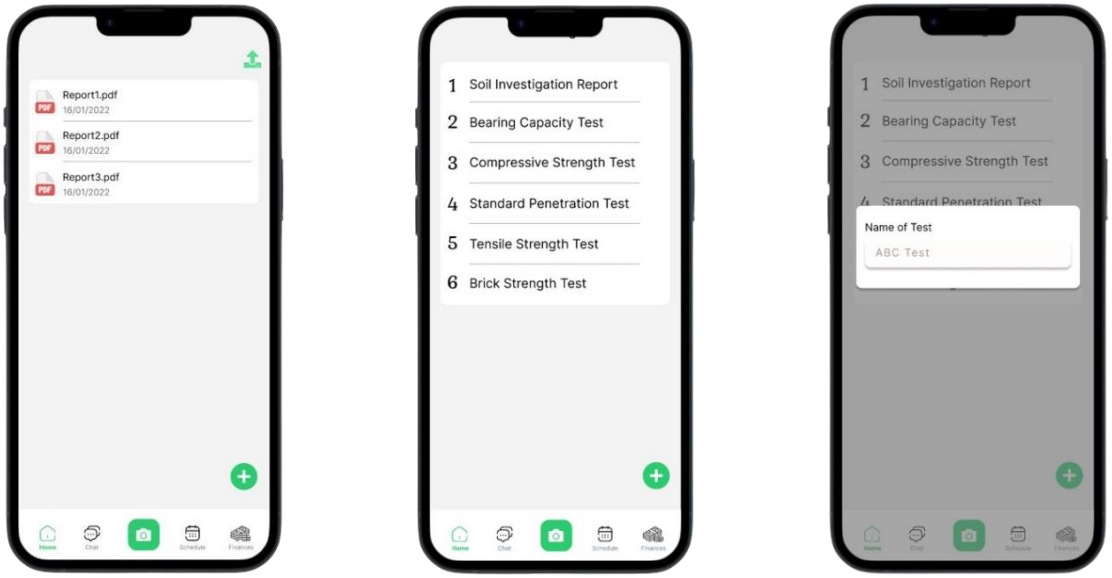
This section includes all reports that have been shared across the platform. Access the "Testing" section to manage and view test-related documents and results. Choose a specific test from the list to view or manage its details.



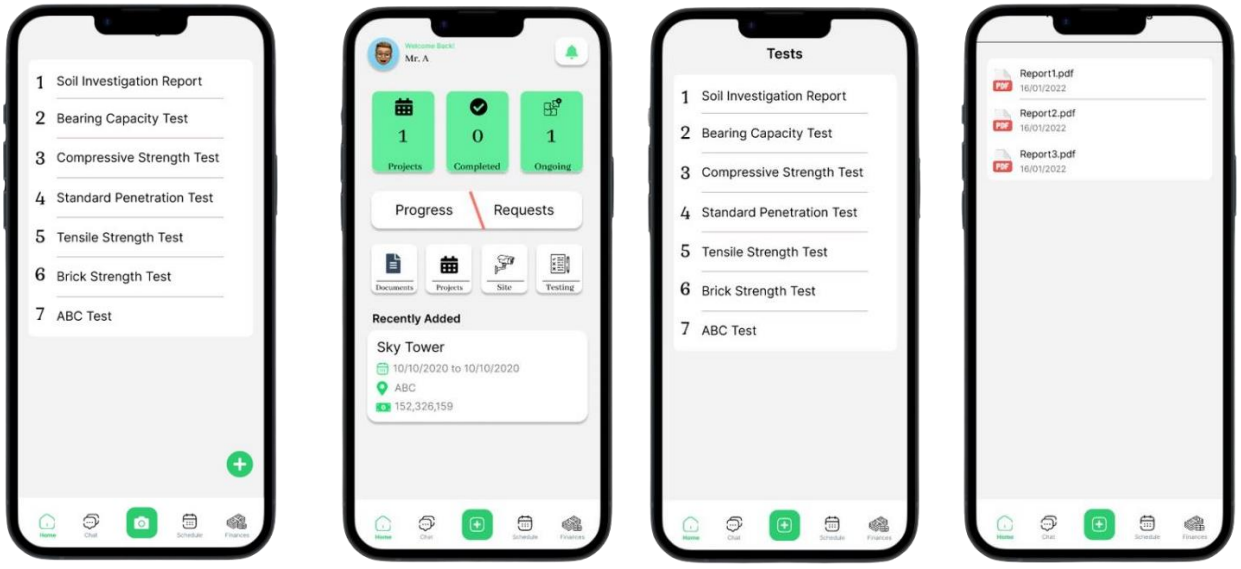




Add the results of the selected test to the platform. Initiate the process to add a new category by clicking the "Create" button. Provide a name for the new category you are creating.



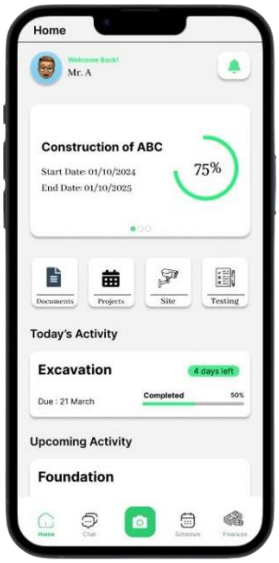
Confirmation that the new category has been successfully created and added to the platform. The results you have uploaded are now accessible to all users on the platform. Choose an existing category to organize documents or results. Confirmation that the results have been successfully uploaded to the selected category.



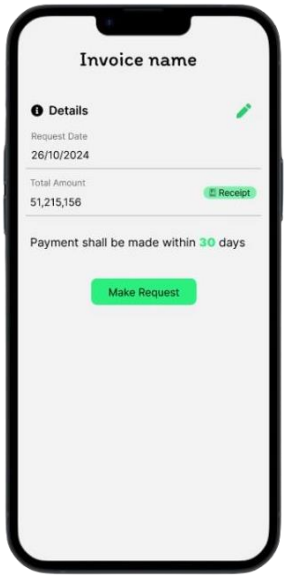
4.3 Financial Tracking:

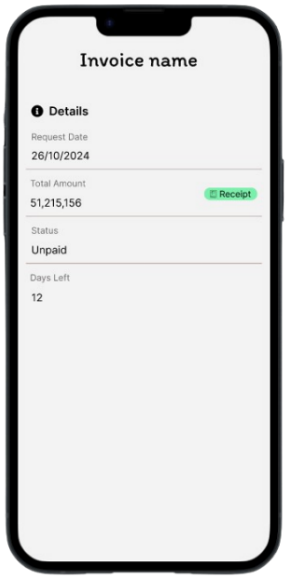
This section delivers us with the possibility to monitor the money spendings in the project as events happen. In this stage, the engineer creates an invoice by entering the requested amount, attaching a copy of the original receipt that has the description of work done therein and all the relevant expenses. Now, this invoice goes for the consultant's signature. The consultant reviews the motion, making the amount required and appending the creed of provided documentation as proofs. From the moment these observations are made, they are emailed to the engineer for confirmation. When the priority was made for the payment, the received amount is also added.

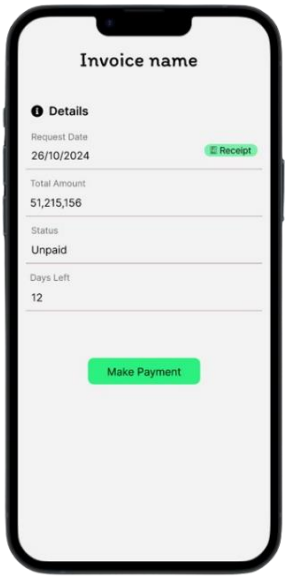
Navigate to the "Finances" section of the platform to manage financial-related activities. Start a new financial entry or request by clicking the "Create" button. Fill in the necessary financial details required for the new entry or request.



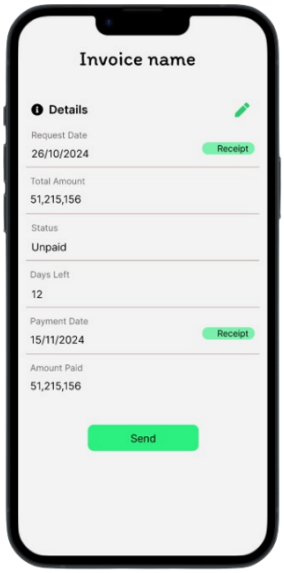
Submit the financial request by clicking the "Make Request" button. The financial request is submitted and will be sent to the relevant party for processing. View the list of Interim Payment Certificates (IPCs) that have been requested and approved.



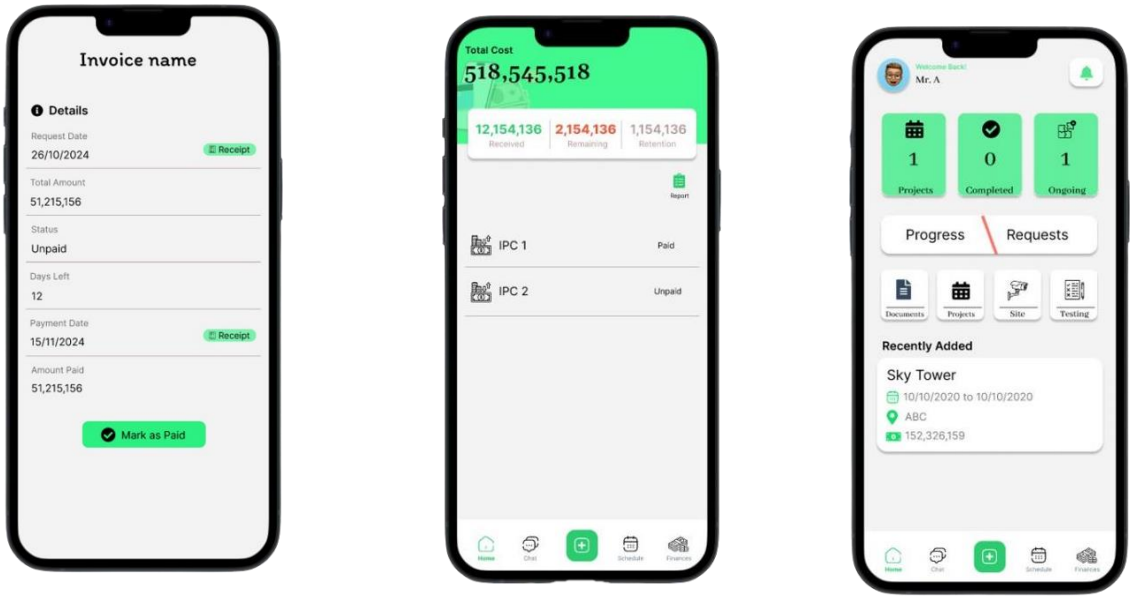




Select a specific requested IPC from the list to view its details. Fill in the required payment details for processing the payment. Submit the payment details by clicking the "Send" button.



Forward the payment details to the engineer for their confirmation and approval. Once the payment is confirmed, mark the IPC as paid by clicking the "Mark as paid" button. The selected IPC is now marked as paid in the system, completing the payment process.



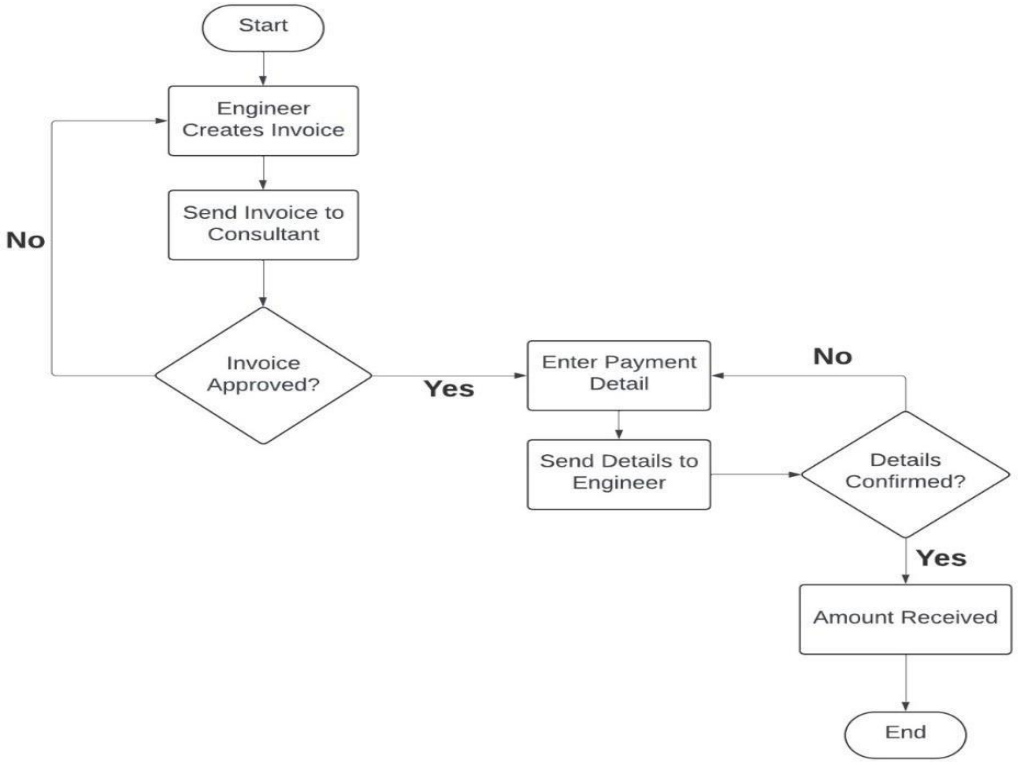
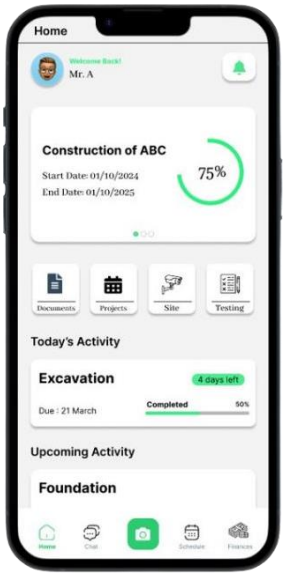


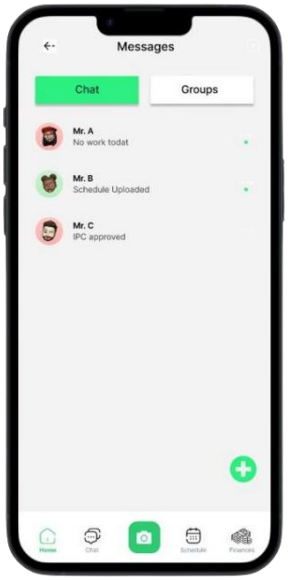
FIGURE 4: WORKING OF MODULE 3

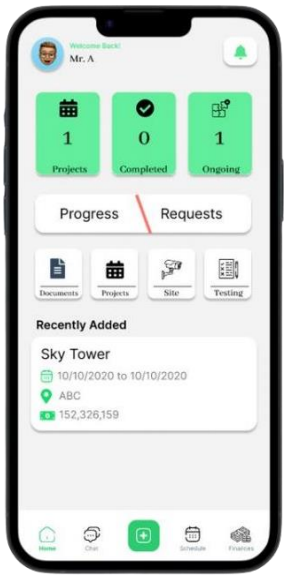
4.4 Chat:

The all the users can connect to each other via the chat option. As the consultantï¼ ’s advice at the beginning of the project, a user becomes available to everyone else working on the same project, which makes communication effective. Users shall communicate either via SMS or audio messages, if need be, and, they can exchange pictures, videos and documents, all of them, for the best decision making on the project under monitoring.

Open the chat feature on the platform. The chat list shows all participants who are part of the project. Type and send a text message to any participant in the chat list.

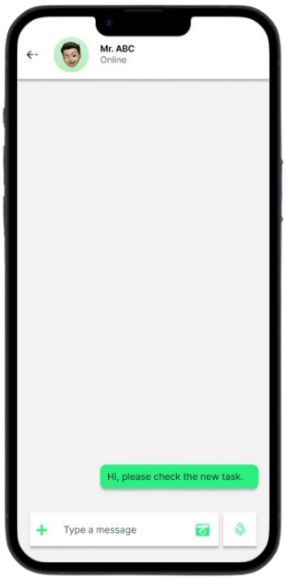






The text message is successfully sent and delivered to the chosen consultant. The audio message is successfully sent and delivered to the chosen consultant. The text

message is successfully sent and delivered to the chosen consultant.



Ability to send videos, images, and other files to participants via chat.

4.5 Discussions

4.5.1 Comparison with existing solutions:

The proposed user-friendly mobile app, which could be tweaked to fit the various contexts, may prove to be more suitable than the existing conventional monitoring methods which could be somewhat limiting, in terms of their capability to handle different situations. Technical innovations like Lidar and 3D scanning greatly increase preferable data collection, however, some countries with low-income struggle to implement them due to the costs and the fact that specialized skills are required, especially in developing countries. In a different way, the mobile application leverages the dissemination of smartphones and tablets, providing an alternative more impractical and affordable solution to a whole variety of projects.

Traditional approaches, which mainly use human reports and traditional paper documentation, have inadequacies embedded that are mainly characterized by the fact that they take too much time, are rendered ineffective, and have version control problems. On the flip side, our mobile application has inbuilt chat tools, real time progress updates, and documents sharing features to promote effective interaction and cooperation among the shareholders. The application achieves all that by magnifying communication channels and guaranteeing the availability of the latest project information to stakeholders in real time using mobile technology, thus dealing with the delays and improving the outcomes.

Moreover, the application intelligence lets the project teams detect schedule deviations promptly and correct them in real time, which again adds to empower their performance. Sharing daily progress updates and instant visual proof through photograph uploads helps to increase accountability and transparency within each team member, thus creating an atmosphere of collaboration and trust among the group. Besides that, if you add a chat feature, it will help to make the process faster when making decisions because it will serve as instant communication way meanwhile financial tracking integration allows for cost management and control for informed budget.

In general, a mobile app works as a smart, up-to-date monitoring method shifting the project from the gray zone to a glaring area of control. All in All, the project

management application, by utilizing smart phone technology, boosts communication, transparency and accountability among team members which leads to success as well as completing projects on time.

4.5.2 impact on project outcomes:

The implications of the mobile app on construction projects are versatile, in vehicle of the app features that are tailored to address different problems faced by various stakeholders. The app serves as a dashboard for the entire project that allows the teams to monitor real-time progress and eliminate the delays that arise due to schedule violation by taking prompt corrective actions. The app gives us the opportunity to keep track of the project progress daily and to come with evidential photos that are provided through the photo uploads and therefore, the app thrives on the area of accountability and transparency among the team members. Transparency creates the environment of collaborative culture where stakeholders, including local communities, media, governments as well as finding investors aid, can easily access up-to-date information and track the various project phases.

Moreover, the software's communication channels, such as the integrated chat module support prompt response and prompt decision mastery by providing efficient communication among project stakeholders. The timely communication ensures that every individual is on the same page regarding the project’s goals, tasks and timelines, thereby increasing the chances of everybody working towards the same direction, and hence, the occurrence of delays and misunderstandings which obviously slow down progress is minimized. And moreover, there is a population of document sharing software to make sure that the project's documents are always accessible through the computer network for anyone who takes part in the decision-making process.

Financial tracking into the app, as a feature, does support better management of project budget and cost control. Through delivering round-the-clock transparency about project resources, sponsors are able to invoke competent decision-making as for where exactly to direct funds and what to do with it. This integration becomes a key tool to eliminate the cost overruns, and the projects can remain within the budgeted constraints which finally boosts financial performance.

Overall, the mix of the features of the mobile application could have a huge potential to improve project schedules compliance and make project budgeting less risky, delay tracking and hence, eventually success rate of a project could be increased accordingly. This provides the stakeholders with the right tools to be able to develop correct decisions, being up to date with the development of the project, being able to communicate effectively and collaborate as required, which results in good projects. Generalizability and limitations: Though the results prove that the usefulness of the mobile application for solving the project's monitoring problems, it is significant to recognize that this study has certain limits and reflective issues regarding the reliability of the generalization. For one thing, the sample size of 37 people might be enough for this study among all the shareholders in the industry. On the other hand, this number may not be comprehensive enough as the stakeholders in the industry are quite diverse. Having multiple construction project roles and tasks, which vary from one worker to another, as well as the bigger and more varied users' sample, future studies will be able to present a more thorough comprehension of how user experience involves different size and kind of buildings. Furthermore, the interviewees in the usability testing were also largely based on the members of the team in several areas of a region closely associated with each other. Whilst the regional setting provides the foundation, this foundation may be limiting in terms of the applicability of findings to construction projects in other geographic locations with a different contextual setting. Ans: While that regional approach serves as a basis, it may restrict as well global applicability of findings to construction projects with different settings as well the contextual factors and challenges on the board. Thus, it needs to be considered that while the findings of the research could hold true for construction industry professionals in general, there is a need for careful generalization to a larger population of the professionals. An additional feature that can further the utility of the mobile app is that it can be used in enhancing the project outcomes through functions such as real time progress monitoring, reporting tools and financial tracking among others. At the same time, however, the functionality of this app can be drastically altered in instances of big and complex projects. Adding extra features, consisting of staff management applications or asset division modules may stabilize further the adequacy of the application for this kind of project. Research and tech development in the future, then, shall be centered on benefiting the community by acquaintance with the limitations of the mobile is and expanding their capabilities.

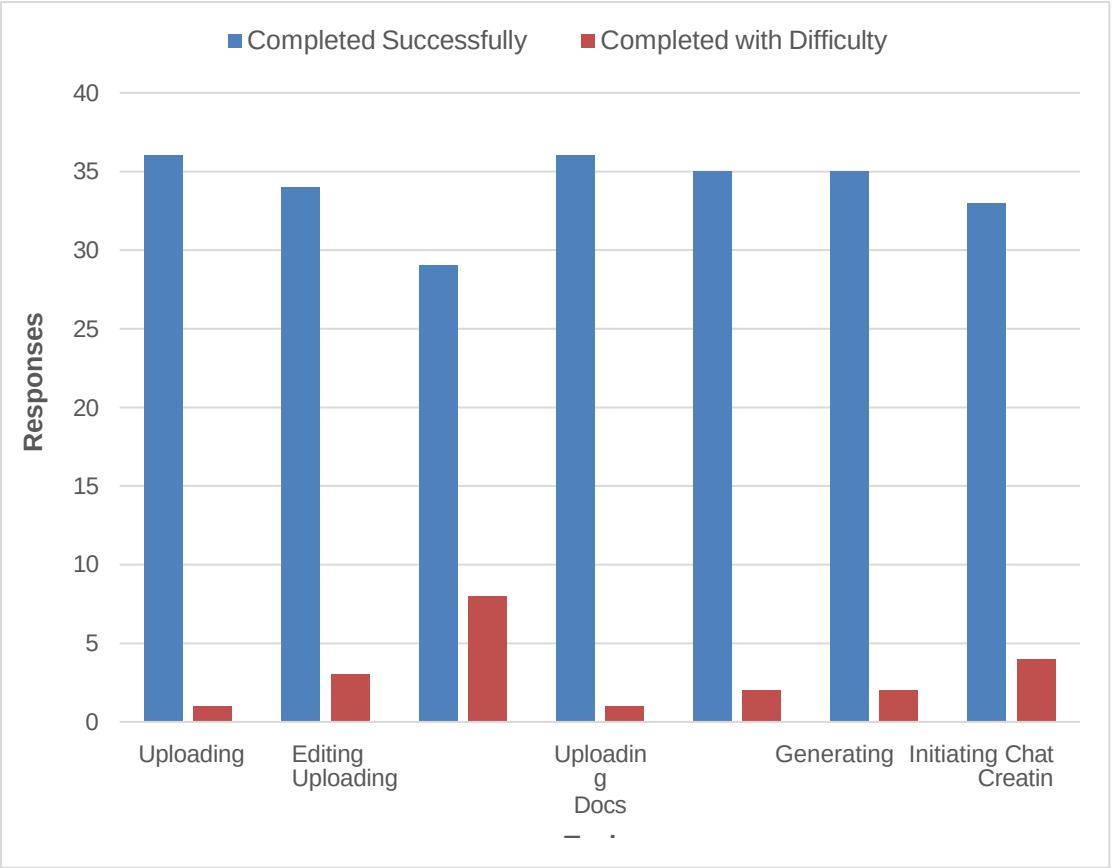


FIGURE 5: SUCCESS RATE OF TASKS COMPLETION

4.6 Conclusion:

1. The significance of progress monitoring and management is embedded deeply in the life cycle of construction projects.

Create ongoing and regular flow of data within projects and timely information updates for supervisors across the region to enable them to make appropriate decisions to mitigate frequent delays and challenges. This becomes essential since on-time completing of projects not only satisfies the customers but also means that the budgets are utilized well, and a good reputation is being upheld. Existing monitoring methods of projects are supposed to have deficiencies of which this research has exposed through a carefully executed literature review. It aimed at them in second place and found out the primary impediments to the adoption of innovative technologies in this domain. To these issues outlaid above, the proposed user-friendly mobile app is, therefore, proposed as a tenant for monitoring construction projects. Taking advantage of the wide utilization of smartphones, this app presents a cheaper undertaking as well as scalable choice for replacing existing intricate monitoring

system. Through the development of instant progress tracking system with joining of communication, documents sharing and cost management features, a single platform is developed which gives edge to tackle broader range of construction project management needs, thus overall project efficiency and success gets enhanced.

For instance, the reliable supervising and control of construction projects, to some extent, this is a very important precondition for successful achievement of projects' goals within the time and budget constraints. Using top of the line tools and tactics among stakeholders makes it possible to reduce risk factors, detect the conditions that might trigger sudden delays and fluctuations and to make smart decisions to enhance and elaborate the existing project workflows. Moreover, not only does monitoring mean that timely progress is ensured but also that all team members have equivalent transparency and accountability that limits chances of disputes or quality issues. Primarily, translating to appropriately developed project monitoring and management not only improves the company’s results but also helps the company to be reputable and competitive in the industry as well.

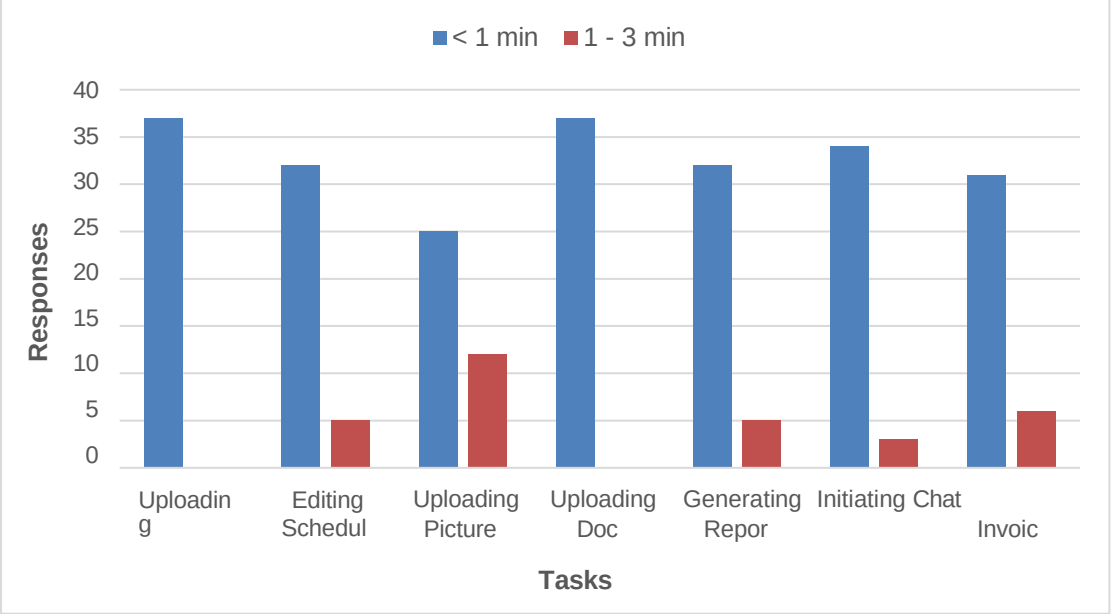


FIGURE 6: TIME TAKEN TO COMPLETE EACH TASK

2. Although recognition of shortcomings of the traditional construction project monitoring techniques is a essential part of the attempt to find new construction industry solutions, it is understood that innovative solutions are required. In example, manual data collection, visual inspection, have been the main methods for progress

monitoring which are traditional ones. Despite the fact that these methods are broadly acknowledged to have numerous disadvantages that make it difficult for an ideal management system to be developed, they are still used in all the companies. For one, manual processes come with these inherent limitations of being laborious and with the possibility of errors, which might make the project assessments not up to the mark. Furthermore, emphasis on the use of paper material and email mode for communication gives birth to difficulties in the management, inconsistencies, and poor collaboration among all relevant parties. These hurdles therefore account for volume of problems that leads to project delay, cost exceeding, disagreements, and finally project termination. Aside from these approaches, nobody can align with stakeholders hence they do not effectively share information and create miscommunication and misunderstanding between them. Consequently, the pinpointing of such deficiencies can be characterized as a crucial area that needs to be focused on in searching modern progress tracking methods for the construction industry.

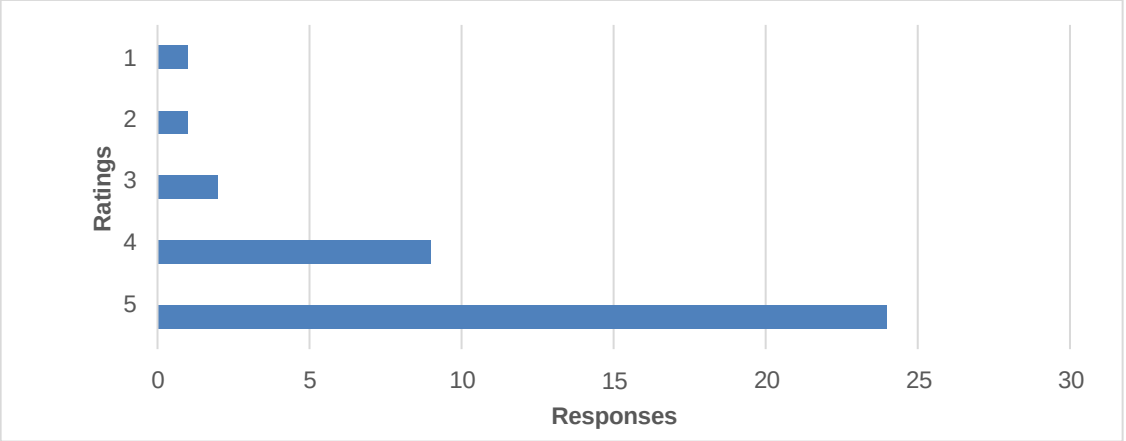


FIGURE 7: USER SATISFACTION

3. Exploration of Limitations in Adopting Innovative Technologies:

The scrutiny of barriers that prevent the acceptance among the construction industry of innovative techniques for the monitoring process had a few major points. Old-fashioned mothering methods (like support data- gathering and paper reporting) that lack efficiency and accuracy have been conventionally used in the sector despite the

cons. This conservativism of advanced technologies is attributed to many reasons and crucial factors include the initial high costs and the already existing skills for using the basic instruments such as sensors, and drones. Besides, there exists a reality of a gap presenting between the realized benefits in using these technologies as one would expect and the actual use in practice in areas with long project delays and faces many implementation challenges.

Besides that, the absence of competence and willingness among construction staff as well as available knowledge of using leading-edge technology acts as a major barrier to obtain its full worth. This indicates that training initiative and education are needed to overcome this knowledge deficiency as it is the only way monitoring solutions that are advanced can be adopted. Moreover, to the change of mind and to the favor of the traditional and well-known methods on monitoring on the project also, there are additional barriers that prevent the adoption of new technology into construction projects.

The mobile application presented here bypasses many of these constraints through providing the sensible option of an economical and convenient alternative to established monitoring products. The smartphone-based app is a good budget friendly option, being a single platform that incorporates data collection, interaction, uploading documents and cost tracking with all in real-time. In this manner, application is addressing the more front end strategic project management issues, while at the same time providing better solutions to both traditional project monitoring methods and advanced technologies accessibility hurdles.

Nonetheless, the approach which involves use of a mobile application represents a good, but the research should go on to identify the steps which could play a role in tackling the resistance of the innovative technologies in the construction project monitoring implementation. This includes exploring the possibility of mobile applications with data capture technologies like sensors or drones, to provide more granular information about the progress of the projects. Moreover, including features for risk mitigation and safety compliance within the app could accentuate and reinforce its utility and value proposition. The release of the app in construction projects at the larger scale provides excellent ground for garnering experience to determine its scalability; therefore, its practical impact thus helping in its

improvement and fine-tuning.

4. Proposal of User-Friendly Mobile Application as a Practical Solution:

For modern construction project monitoring, the main requirement is efficiency and effectiveness. This is especially the case in regions where project delays and challenges are common. For instance, a proposed mobile application that would exempt users from the meticulous collection of data and conveniently organize information is a practical solution that answers the nee

A comprehensive review of literature done for this research has detected the shortcomings of conventional monitoring methods in construction projects and also, identified the hindrances against the widespread adoption of the latest technological innovations. In respect to these drawbacks, the proposed mobile application may be seen as a good challenge riding on the fact that smartphones are used by a larger number of people. Through leveraging the capabilities of smartphones such as this application, it enables cost-effective and readily available option without regard to the social class; the progress monitoring in the construction business is democratizing it. One of the essential functions of the mobile app is the real-time progress monitoring which enables it to do other necessary activities such as, communication, document sharing and cost tracking. This includes components such as tendering and evaluation, stakeholder engagement, risk management, quality control, contract management, and overall efficiency enhancement. All these aims are achieved through close cooperation of all those who are concerned. The Unified Application offers a streamlined solution using its features by consolidating them into a single platform that tackles the challenges of diversity in systems and manual tasks.

We can envision lots of chances for upgrading the application in questions with future research that looks to diversify intelligence offered. Sensors and drones as the cutting-edge data capture components can be integrated with existing methods of collection for the purpose of gaining a higher level view. By holing on to these innovations, the application will be in a more accurate position to detect bottlenecks and provide remedial measures to the stakeholders in advance. Moreover, social niches should also consider adding functions that are connected to the system of risk management or safety protocol to increase their resilience and reduce the potential dangers.

Moreover, there is a need to determine the effectiveness based on a larger scale construction project; this will open up the avenue to such application into the real world. Learning from real world cases where the project has been in action and assessing them within different contexts will inform adjustments and enhancements to the application for wider application. Undoubtedly, the goal of such an app is the realization of a mature and responsive strategy for solving a lot of problems which construction projects monitoring is confronted with, as such an app brings a useful option to all project stakeholders of the industries.

RECOMMENDATIONS:

Based on the analysis provided, several recommendations can be made to further enhance the proposed user-friendly mobile application and its potential impact on construction project management:

1. Consumption of biodiversity-rich areas for tourism development often results in habitat destruction, which is detrimental to the overall ecosystem and biodiversity. Continued Usability Testing: Even though the first usability tests are very positive, continued testing and refinement are crucial to the evolution of the app in order that it becomes more familiar and better for the users every day. Feedback from extra rounds of tests is usually highly useful in tweaking the elements and strengthening the product, too.

2. Integration with Advanced Data Capture Technologies: The research should go on to examine the possibility of combining the mobile App with advanced data capture tools; hence, LiDAR and drones can be used. It may also open new ground for more comprehensive and accurate data collection in regards to project development, offering good guideposts for informed decision-making and ready-made solutions of upcoming issues.

3. Scalability Testing: In the subsequent stage, before putting the app into production it is recommended undergo scale testing that will help in understanding that it can handle a higher number of users and data at one time and still maintain its performance. This practice can trigger finding out the constraints or limitations and could be scaling up in the subsequent process from the result.

4. User Training and Support: For getting the best of the application and making possible its optimum use, it is of utmost importance to have comprehensive user guidance and to provide continuation of support. We will provide tutorials, manuals, and a help desk that will be at their disposal, when interests in using the application or any other related matters

5. Feedback Mechanisms: Feedback capability should be made possible with the app and thereby giving users a chance to upload suggestions, bugs and general experience.

Tending to do the aggregation of user data and analysis periodically assists maintaining the focus on feature enhancements and tackling existing problems on time.

6. Collaboration with Industry Partners: Partnering with the various entities including the construction firms, hardware providers, and regulators will provide practical application based on the real-life scenario.

7. Continuous Improvement: After that, the development team should develop a culture of continuous improvement, it's maintain the application regularly as per the user feedback, technology updates and the sudden industry changes. By keeping the mobile application upgraded as per user needs and the emerging market trends the application can retain its place as a valid tool for construction project management over the long term.

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