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DEVELOPMENT OF AN ANDROID-BASED APPLICATION FOR EFFECTIVE MONITORING AND CONTROLLING OF QUALITY IN RESIDENTIAL PROJECTS

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Abstract: The construction industry in India is rapidly expanding and making significant contributions to the country's GDP. However, numerous challenges such as project delays, cost overruns, poor quality, reduced productivity, safety concerns, and lack of data availability hinder its progress. To address these issues, a research paper proposes the development of an android-based application that efficiently manages office engineering documentation for residential projects. The initial stage of the project involves collecting primary data on the company's details through a questionnaire. The collected data is then analyzed using frequency analysis to identify key patterns and insights. Based on the primary data analysis, secondary data is gathered through interviews and observation surveys. This data serves as a foundation for developing the android-based application. The Android application is designed to provide users with features such as data collection from construction sites, observation of collected data, and overall site management. To test its effectiveness, the application is implemented in a residential project. Site users utilize the application to fill in quality control data, specifically focusing on factors like Services MEP, Placing arrangement during concreting, pour height, slump, ambient temperature, and concrete temperature, for this all factors average of four construction sites 67.86% of Services (MEP) factor, 50% of Placing arrangement factor during concreting, 75% of pour height factor, 42.86% of slump factor, 89.29% of ambient temperature factor, and 85.71% of concrete temperature factor, this all factor not followed during concreting task by site users so, for this lack of information prepare a strategy for construction professional engagement plan and take action in that direction and give training to site users for better improvement. For this research work, researchers have some limitations in the development platform, due to fewer resources of finance to purchase servers and the development of Android applications.

Index Terms **– QA QC, digital document management, android application, digital engagement of construction professionals.**

I. INTRODUCTION

One of the biggest segments of the Indian market is the construction sector. The size of the Indian construction market in the current financial year 2022–2023 (FY23), is INR9.4 trillion, up from INR3.4 trillion in FY22 (Ministry of Finance, 2023). The construction industry in India is now predicted to grow by 5% in real terms in 2023, up from an earlier prediction of a 5.2% growth, according to a new forecast from Global Data. Due to the slowing of global economic growth, foreign direct investment (FDI) has decreased, which is the cause of this negative revision FY22 (Ministry of Finance, 2023).

Many projects contribute to India's GDP growth. But as fast as the industry grows, problems are raised at a low level, affecting construction on a larger level. Concerning the last 12 months, there is 26.6 percent in April 2019 to 58.1 percent in December 2022 of projects are delayed. That gives a cost overrun of 19.7% of the estimated cost (Ribeirinho et al., 2020). Many reasons cause a lacking of quality, reduction in productivity,

exceeding the estimated cost, lack of safety, and delays in projects. But some old methods need improvement to keep up with this faster-growing industry. There are many reasons for this conflict but one of the main reasons is unavailable paperwork or data required to achieve quality, productivity, cost maintenance, safety, and to achieve planned work or construction work. There are many digitalization systems available in the construction industry for quality inspection, improving productivity, safety inspection, planning, scheduling, monitoring, and controlling but a system of paperwork is still the same for general construction work (Srewil et al., 2016).

The construction industry contains so much documentation from the planning phase to the working phase that a lot of paperwork is needed. Sometimes this paperwork causes a lack of quality, productivity reduction, exceeding the estimated cost, lack of safety, and delays in projects(Chitkara, 2005).

Poor documentation caused management issues. The majority of large businesses have a lot of paperwork, which is difficult to complete, and managing safely is a different hard task. Sometimes unavailability of documents may cause big disputes that lead to lacking quality, reduction in productivity, exceeding the estimated cost, lack of safety, and delays in projects. Construction work distance between the site and the main office are usually far and storing document safely on site requires a lot of work. And at the quality inspection, productivity checking, safety inspection, planning, scheduling, monitoring, and controlling are checked on available paperwork. But most of the time paperwork is not available at the time of quality inspection, productivity checking, safety inspection, planning, scheduling, monitoring, and controlling due to any reasons. Of this problem many chances lead to dispute contractor claims for executed work clients claim to not have ideal paperwork of project. The availability of paperwork to everyone involved in this procedure is rarely possible due to all party's different locations. So much paperwork is stashed in office-saving places, and we don't know when their requirements come present.

The industry offers several options to solve this issue, including uploading all papers to a freely accessible platform. Document management is done in so many ways

1) Paper-based document management
2) Web-based document management
3) Application-based document management
4) Cloud-based document management

1.1.Application-based document management

The use of mobile technology in project management is one of the most significant recent advancements. Mobile phone usage is just one of the many advancements that have had a significant impact on society worldwide. To prevent or eliminate kickbacks in construction projects' planning, designing, and building phases, fundamental project management tools are being encoded and integrated into tablets, smartphones, and other mobile devices. There are many different experts and project participants involved, from project consultants to site supervisors, regardless of how simple or complex the building project is. Their goal is to provide good project management to prevent unnecessary time and expense overruns. With the assistance of new applications and technologies made possible by technology, the construction sector is currently experiencing a new-fangled and revived period (Sampson et al., 2020).

The main issues facing the construction sector are how to cut costs, improve productivity, improve quality, and maintain a competitive advantage in terms of service quality and client happiness. As a result of the construction industry's dynamic characteristics, this difficulty is communication-based. outlined the key elements that cause these problems. They claim that the following are to blame for these difficulties:

- The large amount of data that must be transferred and exchanged during a project's building period.
- The team for the building project is divided, and there are frequent site location changes.
- The industry is fragmented in a way that incorporates numerous stakeholders, which causes holes in the data stream.
- The segmentation of work sites and site offices.
- The requirement for appropriate information transfers due to the construction industry's strict deadlines and expensive delays.
- The increasing dependence on subcontractors to carry out construction work is a result of the industry's fragmentation, with at least 80% of tasks carried out on a typical building site being assigned to specialty contractors.

These issues are being resolved because of the ease with which mobile devices have made information transfer and communication. Cost overruns and erroneous construction schedule projections result from poor communication and construction plan management. Mobile project management has accelerated with the advent of mobile devices, which are increasingly evolving into essential tools on construction project sites.

1.2.Areas need to be digitalized in documentation

Figure 1 indicates the areas that need to be digitalized in documentation, these are only a few of the construction department but it is not least.

Figure 1 Areas need to be digitalized in documentation

1.3.Objectives of this research

- To investigate the QA QC documentation practice of residential projects.
- To develop an android-based application that would effectively be monitoring and controlling quality documents.

II. LITERATURE REVIEW

2.1. Introduction

From the diverse literature review, the current document management practice & the digital document Management Method had been studied in elements & each of the techniques had been studied based on their user preference, advantages, disadvantages, or some framework. In various literature, authors have explained about Web-based method, ERP method, Application method, Current method, etc.

2.2. Review paper

Jenco, (2015) This article concentrated on a comparative case study on the adoption of electronic documentation on large-scale civil construction projects. The evaluation looked at the difficulties and advantages of switching from paper-based to electronic documentation systems in the heavy civil construction sector. It examined the reasons for using electronic documentation, including increased productivity, cost savings, greater data accessibility, and simplified project communication. It also covered the specific tools and techniques used for electronic documentation, such as project management software, mobile devices, and cloud-based platforms. This case study included practical illustrations of the implementation procedure, stressing the methods used, the difficulties faced, and the lessons discovered. It looked at how electronic documentation affected collaboration, exchange of information, project coordination, and document management in large civil construction projects. The review's conclusion emphasized the value of change management, training, and continuous support in the heavy civil construction sector's effective use of electronic documentation systems.

Khelifi & Hesham Hyari, (2016) The MoSIC mobile device software, which was created to enhance communication on construction sites, was the subject of this investigation. Create a single system for this study, use it to gather data, and use block testing to analyze it. The review examined the communication difficulties encountered in building projects and offered MoSIC as a remedy to improve the efficacy and efficiency of communications. It emphasized the significance of timely and precise communication to prevent delays, conflicts, and rework in building projects. It covered MoSIC's features and capabilities, including instant chat, file sharing, task management, and collaborative document creation. Additionally, it looked at how using MoSIC can lead to better teamwork, real-time information sharing, better decision-making, and fewer communication gaps. Additionally, it covered the steps involved in putting MoSIC into, practice the need to integrate it with existing systems, take user adoption into account, and specify training needs. It emphasized the successful outcomes and lessons learned from actual MoSIC implementations in building projects. It stressed the potential of mobile device applications, such as MoSIC, to alter communication procedures and improve project outcomes in the construction sector as it came to a close.

Ahmad et al., (2017) The investigation into document management systems (DMS) in Jordan's smaller construction firms was the primary subject of this study. There are three distinct parts to the research. Only the initial stage of the study was covered in this report. During this stage, a review of the literature that looks into current DMSs or the creation and use of new DMS models was done. Additionally, interviews with DMS

users on construction projects were undertaken, and the data were then compared. It looked at the difficulties these businesses had managing their papers and considered the advantages of using DMS. It emphasized the significance of effective document management in building projects to increase efficiency, decrease errors, improve communication, and satisfy legal requirements. It studied the characteristics and functionalities of the various DMSs that are on the market, including cloud-based and on-premise options. It also addressed the difficulties and constraints that smaller construction firms can encounter while using DMS, such as expense, technical complexity, reluctance to change, and lack of knowledge. It highlighted effective strategies and lessons learned while exploring case studies and best practices for applying DMS in comparable environments. It highlighted the potential for DMS to improve document management procedures in small-size construction firms in Jordan and suggested tactics for successful implementation, including running training programs, setting up the necessary infrastructure, and taking into account the particular requirements and limitations of the firms.

Yuan Chin WONG & Kong SAR, (2017) The construction industry's adoption of web-based document management systems (DMS) was the main subject of this study. To meet the study's purpose, a literature analysis, survey, and interviews are undertaken to examine the efficacy and acceptance of web-based document management systems in the construction industry. A few studies have been done worldwide examining the advantages and drawbacks of using a web-based document management system. The merits and shortcomings of these works and conference proceedings are carefully examined. To examine Data gathered from surveys and interviews will be compared to these accounts to examine the variations in how these systems are seen at the advantages, difficulties, and implementation issues related to adopting web-based DMS in construction projects. It emphasized the significance of effective document management in construction projects to enhance collaboration, information sharing, and project outcomes. It covered the attributes and capabilities of a web-based DMS, such as document retrieval, access control, version control, and storage. It examined the possible advantages of web-based DMS, including enhanced project coordination, improved document accessibility, lower costs, and more productivity. It also covered issues including data security, interoperability, user acceptance, and training needs that come with implementing web-based DMS in the construction sector. It included the best methods and tactics for successful installation, such as user education, system integration, and data migration. It offered practical illustrations and insights into the application of web-based DMS in construction projects through the use of case studies, empirical research, and industry reports. It urged additional research to examine cutting-edge technology and changing industry needs. In its conclusion, it highlighted the potential of web-based DMS to alter document management practices in the construction industry.

Kamaraj, (2018) Through emulator testing, it was concentrated on the creation of a mobile application to simplify communication in the administration of building sites. It looked at the difficulties in communicating during building projects and considered the advantages of adopting a mobile app to speed up communication. To promote prompt decision-making, coordination, and problem-solving, it emphasized the significance of excellent communication in construction site management. It examined potential mobile application features and capabilities such as real-time communications, document sharing, task delegation, and progress tracking. It also discussed the criteria and factors to be taken into account when creating the mobile application, such as user interface design, platform compatibility, data security, and system integration. It examined the possible advantages of the mobile application, including enhanced team cooperation, improved project information accessibility, increased productivity, and fewer communication gaps. It provided practical examples and insights into the usage of mobile applications in construction site management by drawing on case studies and empirical research. It highlighted the potential of the mobile application to improve project outcomes and communication processes in the construction industry as it came to a close.

Longmeiwang & Jingsong, (2019) Its main objective was to build a platform for financial sharing services using ERP supply chain management in a cloud computing environment. It looked at the possible advantages, difficulties, and implementation issues related to combining cloud computing with ERP supply chain management in the context of financial sharing services in the construction industry. It emphasized the significance of effective financial management and supply chain coordination in building projects and investigated how cloud computing could improve these processes by enhancing data accessibility, scalability, and affordability. It covered the characteristics and capabilities of ERP supply chain management systems as well as the benefits of implementing them using cloud computing. It also discussed issues like data security, interoperability, and system integration that come with adopting cloud-based ERP supply chain management in the construction sector. It examined the top techniques and tactics for effective implementation, such as system personalization, user onboarding, and ongoing support. It provided real-world examples and insights into the integration of ERP supply chain management and cloud computing in financial sharing service platforms by drawing on case studies, empirical research, and industry reports. It highlighted the potential of

this integrated strategy to enhance supply chain effectiveness, financial management, and overall project performance in the construction industry as it came to a close.

Guo et al., (2021) This study employed comparative analysis to examine electronic document management systems (EDMS) for the transportation construction sector. It looked at the difficulties with document management in transportation construction projects and investigated the advantages of EDMS implementation. It emphasized the significance of effective document management to guarantee prompt and accurate information sharing, enhanced collaboration, and adherence to legal standards in the transportation construction industry. It covered the EDMS's features and capabilities, including document retrieval, storage, version control, and access control. It also covered issues like data security, interoperability, user acceptance, and interaction with current systems that come up while deploying EDMS in the transportation construction sector. It examined the top techniques and tactics for effective implementation, such as system personalization, user onboarding, and change management. It offered practical illustrations and insights into the application of EDMS in transportation building projects through the use of case studies, empirical research, and industry reports. It highlighted the potential of EDMS to promote cooperation, expedite document management procedures, and boost project performance in the transportation construction sector as it came to a close.

2.3. Critical literature review

Several studies have examined the utilization of electronic document management systems (EDMS) and mobile computing technologies in the construction industry. One study conducted in Sweden and Finland focuses on the use of EDMS in project-based construction organizations. It highlights the benefits of EDMS, such as improved collaboration, information accessibility, risk reduction, productivity, and workflow efficiency. The study also discusses implementation challenges, including interoperability, data security, resistance to change, and technological integration. Effective document management techniques like version control, document classification, and metadata management are explored, along with emerging technologies such as cloud-based services, mobile apps, and artificial intelligence.

Another case study examines the use of mobile computing technology for information management on construction sites. It emphasizes the advantages of mobile computing, including information retrieval, data collection, enhanced communication, productivity, and quick data access. Various mobile computing devices like wearables, tablets, and smartphones are considered, along with the importance of user interface design, system integration, data syncing, and addressing issues such as data security, interoperability, user acceptance, and training requirements.

The implementation of EDMS and enterprise resource planning (ERP) systems in construction enterprises is examined in several studies, both at large and small scales. These studies emphasize the need for efficient ERP and document management systems to boost productivity, reduce errors, enhance communication, and comply with legal obligations. They discuss implementation challenges, benefits, approaches, and success criteria for these systems. Additionally, they highlight the significance of change management, training, ongoing support, and strategic planning for successful implementation.

Other research investigates web-based DMS and mobile application development to improve information management and communication on construction sites. These studies discuss the benefits, challenges, and implementation issues associated with these technologies. They emphasize the importance of efficient document management and communication in construction projects and provide examples, case studies, and insights on their practical usage.

In summary, these studies provide a comprehensive overview of the acceptance and application of mobile computing technologies, ERP systems, and EDMS in the construction industry. They shed light on the potential to enhance collaboration, information sharing, project coordination, and overall project management in construction through the exploration of benefits, challenges, best practices, and future directions in these areas.

III. DATA COLLECTION

3.1. Primary data collection

In this research collection of primary data structured survey is used to collect people's responses to this problem. Structured questionnaire created through Google form concerning problem statement. Some supporting questions to create the proper basis for the main problem statement.

1) Which Type of project you worked on?
2) What was the budget of the project you worked on?
3) How many employees are working on the current project?
4) Which method are you using for documentation?
5) Which documents are you following?
6) Have you ever encountered a problem with documentation in any task?

7) What's your experience with the system that you are using?
8) What do you think about a digital system to manage this problem?
9) Would you like it if all the data is available on your phone?
10) Please share your opinion about this problem in a few words.

This question is created for the survey to know respondents' opinion about the problem statement and their needs concerning the problem. 1st question is created to Know which respondents are working on which type of project, if it is suitable to our scope then take this responsibility for this research. 2nd question is created to know if any budgetary limitations are implied in respondents' decisions based on it and to analyze the percentage of cost spent for safety and quality. 3rd question is created to know the productivity of employee engagement on the project. 4th question is created to Know which documentation methodology is used on the project this question helps to research the gap. 5th question is created to Know the types of documents that follow on project based on its analysis quantity, safety, and cost of the activity. that's why the 7th question is generated. 6th question is to state the main problem of the research in the first two questions the area of question is very large that involves all documentation processes of construction and documentation of all projects. Then in research, it's important to know whether respondent reactions regarding the problem are similar or not. The 8th question shows the respondent's experience with the system. 9th question shows the respondent's experience with the system. The 10th question is created to know the opinion about the problem statement. This ratio is for future consideration for the solution of the problem. There is also the main requirement available in the last question that physical paperwork is also mandatory in any task So enhancing the process by maintaining the paperwork is the most considerable limitation.

3.2. Secondary data collection

Secondary data collection for this research used a qualitative methodology based on primary data collection. For this, collect data from four building construction organizations that actively employ paper-based document management systems were observed, and interviews with the project manager, QA/QC engineer, and site engineer were also conducted. For this research work collected quality control by checklist and Daily progress report and based on it prepared different formats of input data checklist for application and take validation from QA/QC engineer have experience more than 16 years and worked at building construction sites, Project manager have experience about more than 26 years he gives me suggestion regarding my project is to take a suggestion from site engineer also, Project engineer have experience about 14 years he suggest me to it is difficult to apply in routine practice, and from site engineer have experience 7 to 8 years and worked at building construction site. This is all validation done by residential building construction employees.

3.2.1 Development of a mobile application

A mobile application is developed based on the inputted data, main objective of the application development is to explain the viability of a mobile application prototype for enhancing communication and managing on-site information in construction projects. The required information for the mobile application was selected from the input data. Figure 2 demonstrates the input parameter for the Mobile Application.

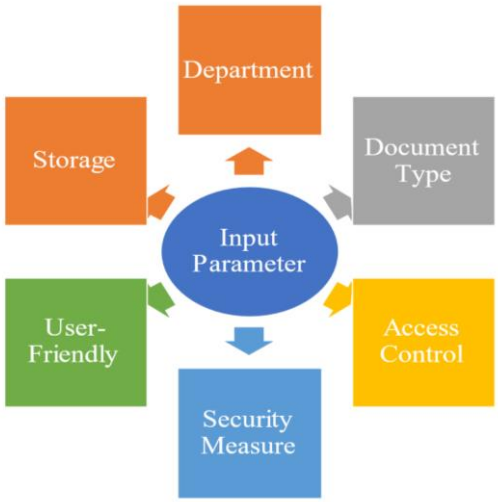


Figure 2 Input Parameter

Table 1 Access Control

Functional Requirements	Access By
Installation of application	All users
Add projects	Main office employee
Modify projects	Main office employee/Site office employee
Delete projects	Main office employee/Site office employee
Add details	Site employee
View project reports	Main office employee/ Site office employee

3.2.2. Process of preparation of mobile application

Figure 3 displays the process of preparing the mobile application based on the system design life cycle methodology. (Learning, 2013)

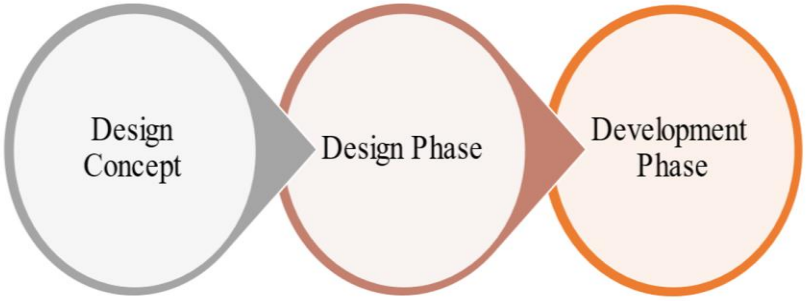


Figure 3 Process of Mobile Application

Design concept

The first stage of research on design requirements for developing the application. Some programming languages such as Windows Mobile and MIT App Inventor were selected for developing the mobile Application in the primary phase.

Design phase

In this phase prepare an application design, and the overall structure of the application should be prepared Moreover, the number of layers of the application and the server should be decided.

Development phase

The paper-based documents should be translated into block language at this stage. MIT App inventor can convert application components such as table formatted texts, menus, etc. into block codes. To develop the application, a mobile version of APK was designed. This allows the APK to be accessible through mobile devices.

Background work of Application

The application code is compiled and built using a cloud-based system in the background by MIT App Inventor. blocky, a visual programming language that enables users to generate code using blocks that represent various instructions and functions, is the programming language used by the platform. Users can leverage the platform's extensive library of pre-built code blocks to build a variety of functionalities into their applications, such as accessing the camera, sending SMS messages, or accessing the internet.

When the responder fills the data in the application and clicks on the save then the save button is directly connected to the server it is a spreadsheet at that time that data goes to the server spreadsheet. **Error! Reference source not found.**4 shows the background work of the mobile application platform used by the researcher for this research work.

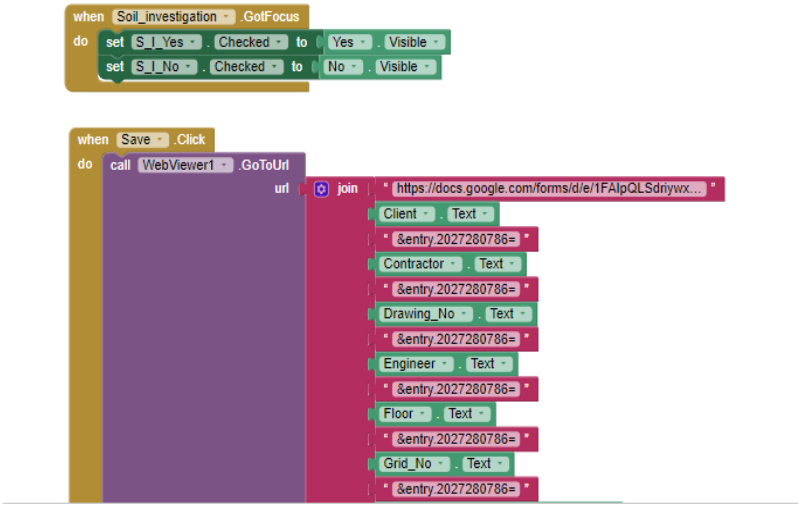


Figure 4 Operation of Application

3.2.3. Operation of Application

Below Figure 5 shows the operation of the mobile application, and how to use it.

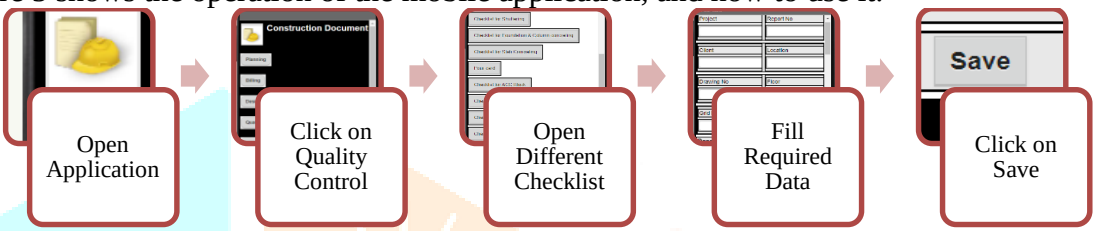
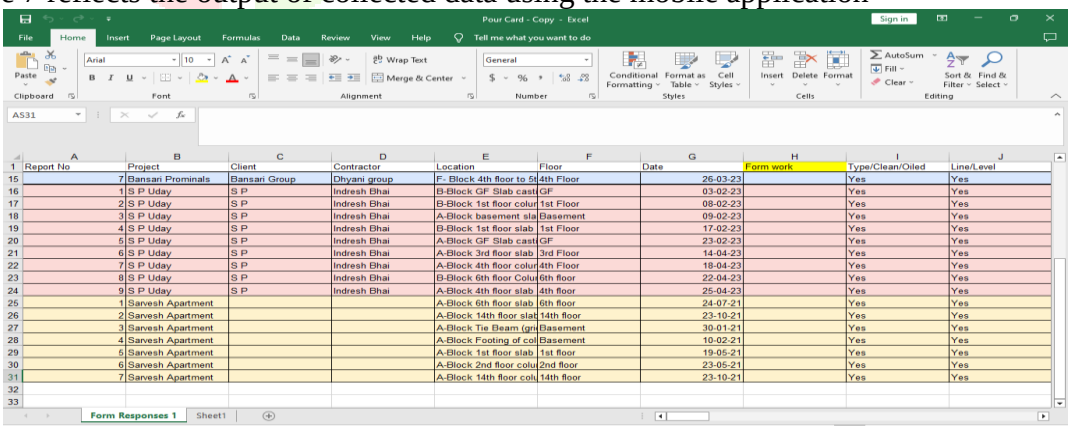


Figure 5 Operation of Application

After data collection application gives some output parameters Figure 6 depicts the output parameters of the mobile Application.

Figure 6 Output Parameter

Below Figure 7 reflects the output of collected data using the mobile application



Report No	Project	Client	Contractor	Location	Floor	Date	Form work	Type/Clean/Oiled	Line/Level
7	Bansari Prominals	Bansari Group	Dhyani group	F- Block 4th floor to 5t	4th Floor	26-03-23		Yes	Yes
1	S P Uday	S P	Indresh Bhai	B-Block GF Slab cast	GF	03-02-23		Yes	Yes
2	S P Uday	S P	Indresh Bhai	B-Block 1st floor colur	1st Floor	08-02-23		Yes	Yes
3	S P Uday	S P	Indresh Bhai	A-Block basement sla	Basement	09-02-23		Yes	Yes
4	S P Uday	S P	Indresh Bhai	B-Block 1st floor slab	1st Floor	17-02-23		Yes	Yes
5	S P Uday	S P	Indresh Bhai	A-Block GF Slab cast	GF	23-02-23		Yes	Yes
6	S P Uday	S P	Indresh Bhai	A-Block 3rd floor slab	3rd Floor	14-04-23		Yes	Yes
7	S P Uday	S P	Indresh Bhai	A-Block 4th floor colur	4th Floor	18-04-23		Yes	Yes
8	S P Uday	S P	Indresh Bhai	B-Block 6th floor Colu	6th floor	22-04-23		Yes	Yes
9	S P Uday	S P	Indresh Bhai	A-Block 4th floor slab	4th floor	25-04-23		Yes	Yes
1	Sarvesh Apartment			A-Block 6th floor slab	6th floor	24-07-21		Yes	Yes
2	Sarvesh Apartment			A-Block 14th floor slat	14th floor	23-10-21		Yes	Yes
3	Sarvesh Apartment			A-Block Tie Beam (gri	Basement	30-01-21		Yes	Yes
4	Sarvesh Apartment			A-Block Footing of col	Basement	10-02-21		Yes	Yes
5	Sarvesh Apartment			A-Block 1st floor slab	1st floor	19-05-21		Yes	Yes
6	Sarvesh Apartment			A-Block 2nd floor colu	2nd floor	23-05-21		Yes	Yes
7	Sarvesh Apartment			A-Block 14th floor colu	14th floor	23-10-21		Yes	Yes

Figure 7 Data Output

IV. DATA ANALYSIS

4.1. Primary data analysis

It begins with a frequency analysis of the general questions and answers of participating firms and respondents. The data analysis of the collected data is done as frequency analysis. The total number of responses finalized to conduct the data analysis of the survey is 20. The data collected from the above questionnaire are the basic information of the respondent about the respondent's work on which method of documentation and its budget or problem faced due to documentation.

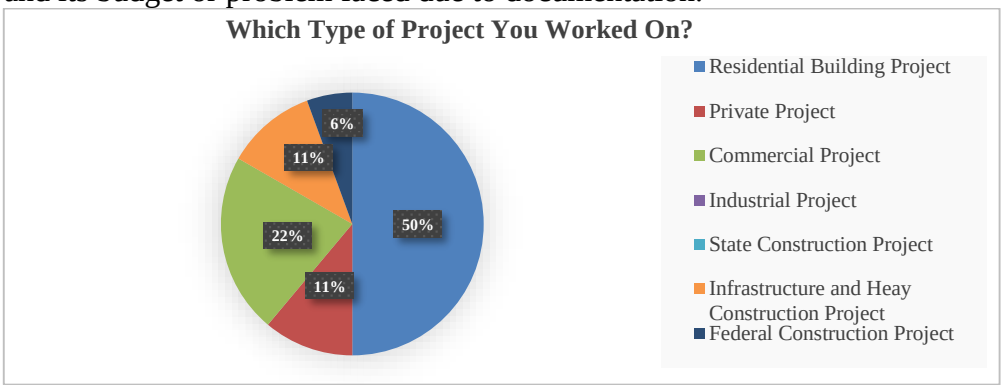


Figure 8 Which type of project you worked on

Based on analysis Figure 8 demonstrate that 50% of the total respondents are working on residential projects. So, for this research work researcher select residential projects.

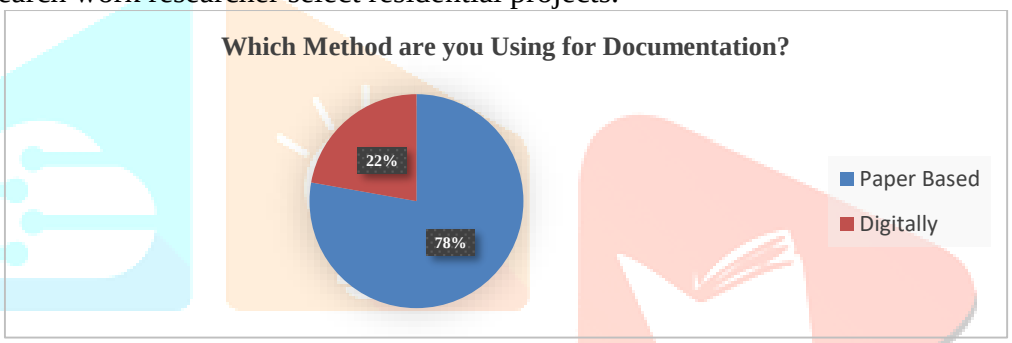


Figure 9 Which method are you using for documentation

Based on this question analysis Figure 9 indicates that 78% of the people are using paper-based documentation in the construction industry in this response the main variation is seen.

Table 2 Type, Method, Cost, and Problem Regarding Project

Type of Project	Method of Documentation	Cost of Project	Have you ever encountered a problem with documentation
Residential Building Project	Paper Base	40 crores	Yes
Residential Building Project	Digitally	2-3 crores	No
Infrastructure and Heavy Construction Project	Paper Base	1 to 2 crores	No
Private Project	Paper Base	1 crore	No
Infrastructure and Heavy Construction Project	Paper Base	21 crores	No
Federal Construction Project	Digitally	90 crores	Yes
Residential Building Project	Paper Base	50 crores	No
Residential Building Project	Paper Base	70 crores	Yes
Commercial Project	Paper Base	5.25 crore	Yes
Commercial Project	Paper Base	25 crores	No
Residential Building Project	Paper Base	30 crores	No
Private Project	Paper Base	80 lacks	No
Residential Building Project	Paper Base	50 crores	yes
Residential Building Project	Digitally	85 crores	No
Commercial	Paper Base	150 crores	No
Residential Building Project	Paper Base	75 crores	Yes
Residential Building Project	Digitally	70 crores	No

By Table 2 data, we can say that the digital documentation process is of lesser use in higher-budgeted-cost projects. Based on this analysis researcher consider an average of 60 crores of projects for this research work. During the construction period, many documents are required Figure 10 illustrates which type of documents they are following for construction work.

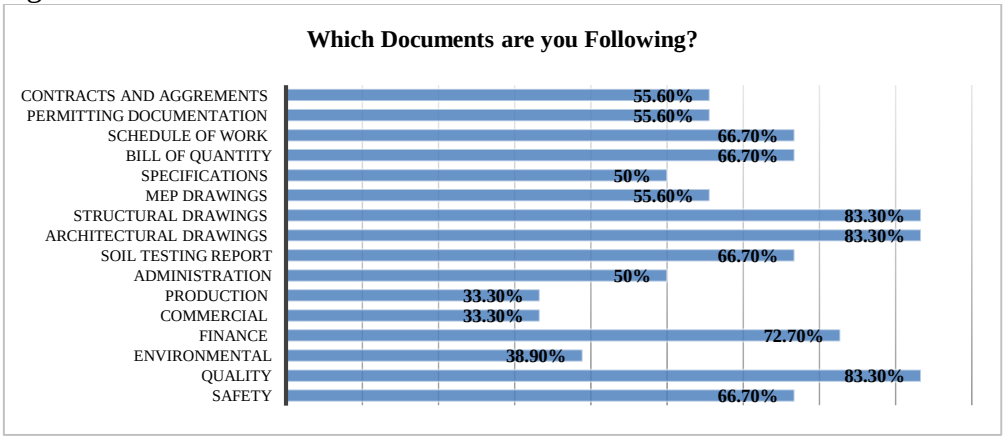


Figure 10 Which Documents are you Following?

During execution work, so many documents are mainly important on-site like a schedule of work, BOQ, Specification, Drawings, Test Reports, Quality, and Safety. Based on this survey analysis 66.70% of respondents use a schedule of work on site but it is most important to continue work on schedule, 66.70% of respondents use BOQ on site but is important to know activity cost, and based on it they can control and monitor the cost. 55.60% of respondents follow MEP Drawings so they can prevent clashing. 83.30% of respondents follow Structural and Architectural drawings. 66.70% of respondents follow soil testing reports so, based on the soil test report's structure engineer can prepare a structured schedule. 83.30% of respondents follow quality documents after a discussion with respondents they say we are only following test reports only not follow the checklist properly. 66.70% of respondents follow safety documents it is the most important documents on-site.

In this research work researcher choose a quality control part, due to this survey 83.3% of the people used quality documents but they are only following test reports they do not follow quality control by checklist.

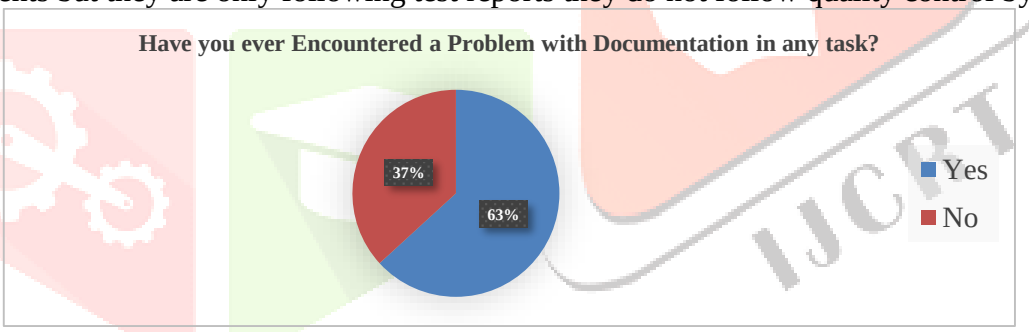


Figure 11 Have you ever encountered a problem with documentation

Based on this question's analysis Figure 11 shows that 37% of total respondents are facing problems due to documentation in any task during the construction period.

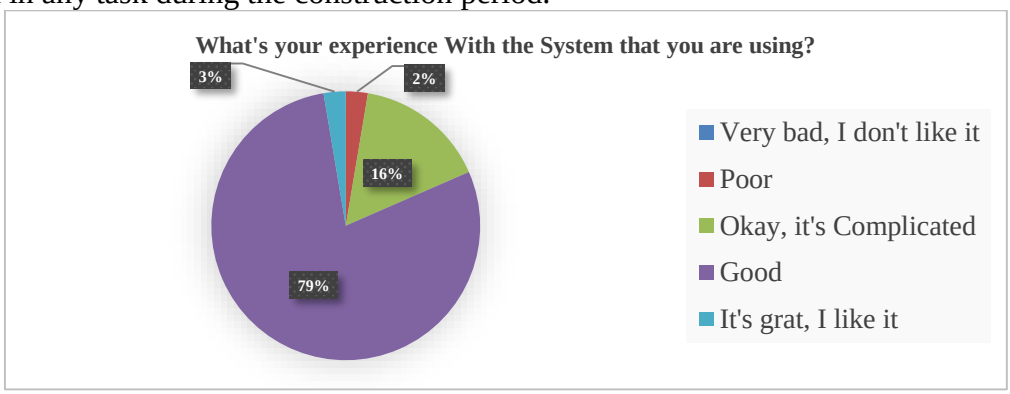


Figure 12 What's your experience with the system that you are using

Based on **Error! Reference source not found.** for documentation? It's important to know respondents' behavior against the problem to find an accurate solution to the problem or even to identify the problem.

By this, we can say that 79% of the respondents are happy with the past method but some respondents also required a solution to update this old method.

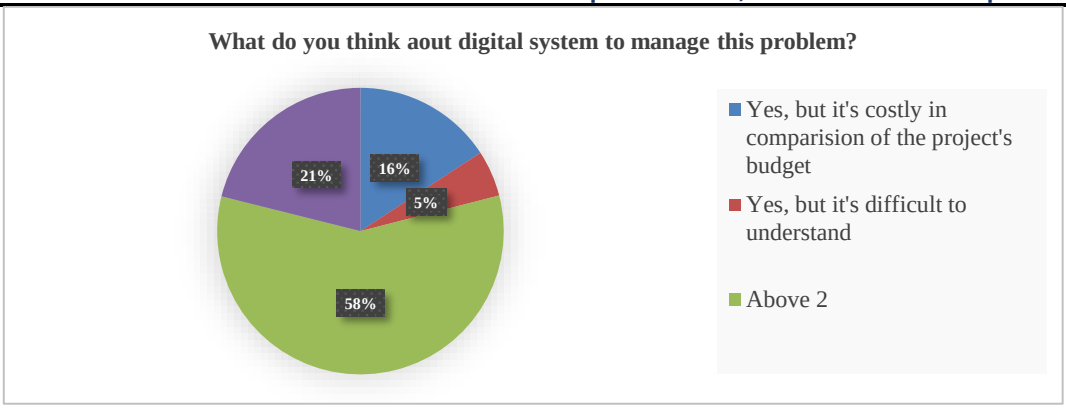


Figure 13 What do you think about a digital system to manage the problem

From Figure 113, we can see from the above graph that 58% of respondents are considering that the Digital system is costly and difficult to understand for everyone. This respondent cannot use digital systems due to these problems.

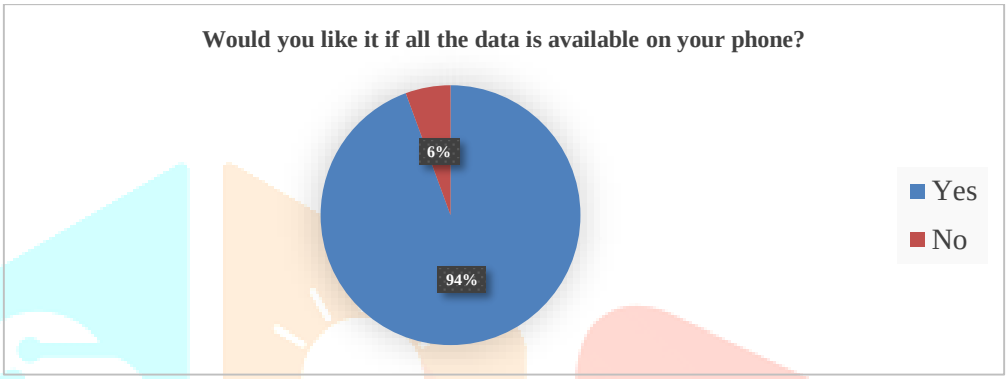


Figure 14 Would you like it if all the data is available on your phone

Based on Figure 14 This ratio is for future consideration for the solution of the problem. Where 94% of people are ready to work with a phone. There is also the main requirement available in the last question that physical paperwork is also mandatory in any task So enhancing the process by maintaining the paperwork is the most considerable limitation.

4.2. Secondary data analysis

This chapter presents data analysis as well as the findings from the experiment. It begins with a frequency index analysis of the general variables of participating firms and respondents. The data analysis of the above-collected data is done in Excel using different functions of Excel and bar charts. The total number of firms finalized to conduct the data analysis of the survey is 4. The data collected from the application are the information of the pour card.

Summary data of all site

Table 3 Summary of all Data

Sr. No	Factors	Yes	No
Form Work			
1.	Type/Clean/Oiled	96.43	3.57
2.	Line/Level	92.86	7.14
3.	Falsework	46.43	53.57
4.	Joints/Security	92.86	7.14
5.	Key/ W-bar/Joints	96.43	3.57
6.	Blackouts/Fixings	67.86	32.14
7.	Services (to be signed off by services contractors)	32.14	67.86
Reinforcement			
1.	Type/Size/Clean	96.43	3.57
2.	Fixing/Chairs	67.86	32.14
3.	Spacing	96.43	3.57
4.	Concrete cover	96.43	3.57
Pre-Concreting			
1.	Pour height	25	75
2.	Final Clean	100	0
3.	Placing arrangement	50	50

During Concreting			
1.	Slump (mm)	57.14	42.86
2.	Ambient Temp.	10.71	89.29
3.	Concrete Temp.	14.29	85.71
4.	Cubes	57.14	42.86
5.	Compaction	100	0
6.	Alignment	96.43	3.57
7.	Level	100	0
8.	Curing	100	0
Post Concreting			
1.	Clean Up	100	0
2.	Stripping	100	0
3.	Making Good	100	0

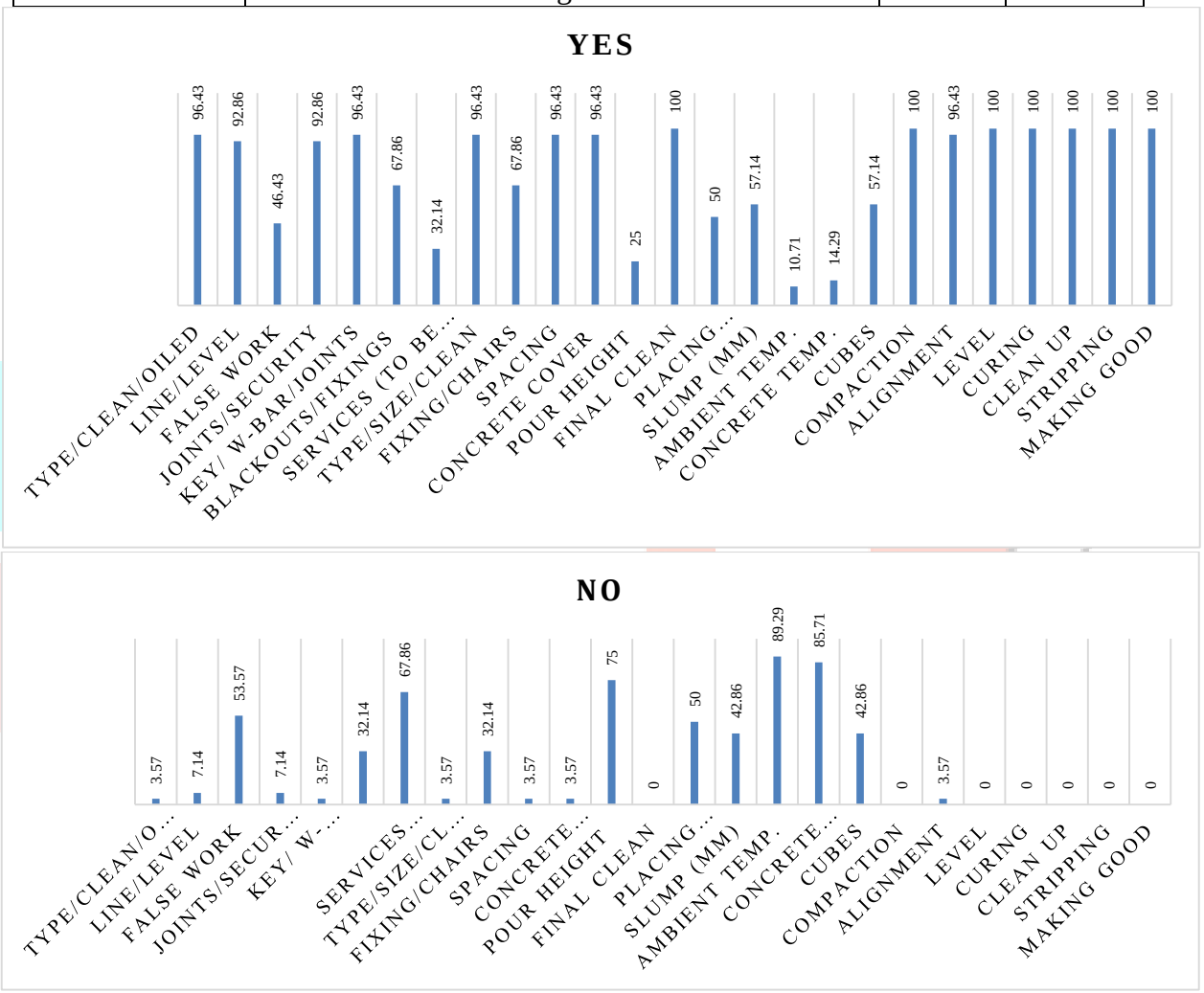


Figure 15 Factors of Pour card

The grey area of sites

For this researcher consider factors that 40-100% of negative response and from that takes the most important factors only.

The grey area of the sites

Table 4 Grey Area of the Site

Sr. No	Factors	No
Form Work		
1.	Services (to be signed off by services contractors) MEP	67.86 %
Pre-Concreting		
1.	Pour Height	75 %
2.	Placing arrangement	50 %
During Concreting		
1.	Slump (mm)	42.86 %
2.	Ambient Temp.	89.29 %
3.	Concrete Temp.	85.71 %

Strategy for Construction Professional Engagement

1. Inspection for MEP Services

Table 5 Inspection for Services

When	Before and During Concreting
Where	Concreting Location
Who	Users from the residential projects, including MEP Consultants, Contractor's engineers, and Client's engineers.
How	Planning and coordination with services contractor and Structure engineer and architecture, check design, check clash detection, pre-installation check, check quality assurance, and provide proper clearance.
Goal	To accurately placement of services, early problem detection, cost time-saving and safety improvement.
Outcome	Minimum time and cost reduction.
Tolerance	Alignment and level, clearance, fixtures size, connection, and fixtures placement as per design specification.

2. Inspection for Placing Arrangement (Pumping/Dumping)

Table 6 Inspection for Placing Arrangement

When	Before and During Concreting
Where	Concreting Location
Who	Users from the residential projects, including Client's engineer, Contractor's engineer, Project manager, and RMC skill person.
How	Before the start of concreting check, the placing arrangement of concreting which method is easy for which element of casting and reduce time and manpower cost.
Goal	To Faster placement, access to the site, better quality, cost savings, and safety.
Outcome	Minimize time, achieve better quality, and reduce cost.
Tolerance	For Pumping: Pressure and flow- for direct action pumps 60 m3/h can be achieved with 220-mm diameter pipes. For squeeze-type concrete pumps, 20 m3/h can be achieved with 75-mm diameter pipes. For Dumping: Up to 1 meter in height and 1.5 meters in distance is acceptable for dumping

3. Inspection for Slump

Table 7 Inspection for Slump

When	During concreting
Where	Concreting Location
Who	Users from the residential projects, including client's engineer, contractor's engineer, consultant, Lab technician, QA/QC engineer, and Project manager.
How	Before the start of concreting do a slump test. If found failed test result is then adjusted the water content, modified aggregate proportion, use admixtures, adjust the mix design, and consider temperature.
Goal	To achieve consistency, workability, and control on concrete placing procedure and concrete setting time.
Outcome	Achieve better quality
Tolerance	Heavily reinforced sections in slabs 50-100 mm and for beams, and walls. columns; Slipform work; Pumped concrete 75-100 mm. (IS 456, 2000)

4. Inspection for Ambient Temperature

Table 8 Inspection for Ambient Temperature

When	Before and During Concreting
Where	Concreting Location
Who	Users from the residential projects, including client's engineer, contractor's engineer, Concrete Supplier, QA/QC engineer, and Project manager.
How	Pre-construction planning like checking weather forecasts, shading, etc. Concrete mix design like choosing low-heat cement, maintaining water content to reduce the heat of hydration, adding admixtures, etc. Provide cooling techniques and quality control.
Goal	To measure concrete strength, workability, crack prevention, and durability of concrete.
Outcome	To achieve the required strength of concrete
Tolerance	Any operation of concreting done at atmospheric temperatures above 40°C or any operation of concreting (other than Item curing) where the temperature of concrete at the time of its placement is expected to be beyond 40°0 (of Indian Standards, 1975)

5. Inspection for Concrete Temperature

Table 9 Inspection for Concrete Temperature

When	During Concreting
Where	Concrete Location
Who	Users from the residential projects, including client's engineer, contractor's engineer, Concrete Supplier, QA/QC engineer, and Project manager.
How	Concrete mix design like choosing low-heat cement, maintaining water content to reduce the heat of hydration, adding admixtures, etc. Placement techniques like decreasing transportation distance, dividing large areas, or pouring into small areas, etc.
Goal	To control setting time, consistent quality, and following standards of concrete.
Outcome	To achieve a better-quality concrete
Tolerance	According to IS 456:2000, the temperature of fresh concrete at the time of placement should generally be maintained between 10°C and 35°C. This range ensures workability and proper hydration of the concrete. (IS 456, 2000)

6. Inspection for Pour Height

Table 10 Inspection for Pour Height

When	During Concreting
Where	Concrete Location
Who	Users from the residential projects, including client's engineer, contractor's engineer, QA/QC engineer, concrete contractor, and Project manager.
How	Before the start of concreting define the poring method, use temporary supports, use pouring equipment, implement in formwork system, etc.
Goal	To achieve consistency and quality control.
Outcome	To achieve better quality

Tolerance	Up to 1 meter

V. RESULTS

Based on primary data analysis researcher choose a digital system because 94% of respondents were ready to work with a digitalization system, 78% of respondents used paper-based documentation systems in higher budgeted-cost projects, 37% of respondents are facing problems due to documentation in any task during construction work, 83.3% of the people used quality documents but they are only following test reports they do not follow quality control by checklist. and 50% of respondents are working on residential projects so, for this research work researcher selects residential projects that are budgeted on an average of 60 crores and selects quality control by checklist.

In this paper, the development of android based application is presented that would effectively manage office engineering documentation in residential projects. For secondary data, collected 4 sites data through the application show some lack of availability of information factors needed for construction work like Services MEP, Placing arrangement during concreting, pour height, slump, ambient temperature, and concrete temperature, for this all factors average of four construction sites 67.86% of Services (MEP) factor, 50% of Placing arrangement factor during concreting, 75% of pour height factor, 42.86% of slump factor, 89.29% of ambient temperature factor, and 85.71% of concrete temperature factor, this all factor not followed during concreting task by site users so, for this lack of information prepare a strategy for construction professional engagement plan and take action in that direction and give training to site users for better improvement.

For this research work, researchers have some limitations in the development platform, due to less resources of finance to purchase servers and the development of Android applications. If anyone wants to work with more finance then they can work with it and get more access to servers.

VI. ACKNOWLEDGMENT

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