

Development, Implementation and Comparison of Mobile Application with Traditional Method for Scheduling on Construction Site- Project MasterPlan

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Abstract – The Construction industry is crowded with many challenges and also a window for enhancing opportunities in future. Modernization and Digitalization has changed the face of the world. There's an industry transformation happening in construction, driven by modern technology, and these changes are significantly elevating construction management. Contractors are finding ways to modernize their business with digital software that improves productivity and mitigates risks, while increasing their bottom line. Getting there just requires finding the right construction-specific tools. One of the most enhancing technology that has been seen since few years is Mobile technology. Mobile Applications and software's have proved to be the most comfortable, speedy and useful technology in construction Industry. Thus, this paper introduces a mobile application for betterment in scheduling and planning process considering labours and equipments. The mobile application is known as "Project MasterPlan-Planning, Labour and Equipments". The Mobile application focuses on planning and scheduling of the project on the construction site. Just by uploading the company's schedule calendar in the application, user can work on project on set time and avoiding delays. The application focuses mainly on working on pre-set schedule by giving notification and reminders if any task is delay. This helps the user to work on project on time and can be prepared for upcoming tasks. This paper finally compares the reports of the project created by the application and project carried out by traditional method.

Key Words: Construction Site, Mobile Application, Scheduling, Project MasterPlan Application, Delay

1. INTRODUCTION

The construction industry is known to be an indicator for Infrastructure Development in a country. This industry is a combination of lots of challenges such as financial issues, problems in the supply chain, scarcity of skilled labours and the crucial problem is planning and scheduling. Scheduling of any construction project is said to be the most key component of a project as well as an onerous job within a

project. It seems that the majority of the project is unsuccessful only because of improper scheduling and lack of implementation of estimated plans. In the Construction Industry scheduling is known as a process of listing tasks, work activities of a particular project in accordance with planned start and finish dates. Digitalization in construction has enhanced the way of construction [16]. The construction industry involves many Mobile Applications for its ease [32]. It is important to clarify the necessary activities, terms that are to be implemented for better execution [28]. Lack of knowledge in the project management will result in unsuccessful project performance. Considering scheduling the project performance is unsatisfactory [23] [29]. The construction projects are very often delayed not only because of improper scheduling but also improper management of Manpower and modern machinery. A mobile phone or a Smartphone is integrated with advanced computing capabilities [30]. "A successful Project management is the technique of implementation of knowledge, skill, tools, and techniques to meet project requirements". The mobiles and smartphones have special characteristics such as it is light in weight, portable, small size that can be carried in pockets and these devices are expert as a communication tool [31]. These devices can be used on the project site to improve the timeliness of the work and help to reduce cost [26]. The potential of mobile technology devices offers many technologies into one device [36]. Mobile technology manages employees, equipment, communications, and schedules in single devices through mobile applications. The staff on construction sites uses mobile devices which develop a positive attitude towards new concepts and computerized solutions [3] [9]. The management of daily on-site activities leads to progress of the project. **Everything is being tracked on the go!**

1.1 Introduction to Mobile Application

Mobile Applications are known for their ease of working and comfort. The construction industry lacks in on-time completion of work. Thus, it is primarily to overcome such

drawbacks. This mobile application gives a new vision for scheduling. It will help to reduce the difference between the estimated scheduled time for completion of the project and the original time needed for completion of the project. This reduces delays in the construction project. Basically, the mobile application can be used to complete the assigned task within the time that will result in the on-time completion of the project. The schedule of the project is updated in the mobile application according to its start date and estimated completion dates. The applications will give an alert or warning notification for every task if the work is not completed within the scheduled time. This notification keeps the project manager aware of the next task.

Schedule or planning done before the commencement of work is to be uploaded in the application according to the sequence of work. Each and every task is to be uploaded in the application along with the time for a particular task. Each work along with starting date and estimated end date of the task is uploaded. The application gives the notification about the task whose date of completion is near so the notification date has to be set in prior. Notification is given by the application according to the set date and time. After setting all the dates or particular task resources such as human and types of equipment is to be added for each task. Notification helps the project manager to complete the work within time as it gives the alert to avoid delay. This provides a warning to the manager to complete the particular task and proceed to the next task. As the next work is known in advance it gives time for the manager to prepare for the next task. The types of equipment required for the next work are known prior so the manager can book or rent it in advance which will avoid delay for further work. Preparations can be done prior to the next task which will reduce the extra time required for preparations. Thus, this application can reduce the preparation time and avoid unnecessary delays.

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2. OBJECTIVE

The main objective of the paper is to develop a mobile application for scheduling to overcome delays and compare the process of work by Mobile application that is Project MasterPlan with traditional method of working. The mobile scheduling application encourages solving the construction project planning problems. Working according to schedule is the most challenging task in the construction industry. Many of the projects are delayed mainly due to not working properly according to the planned schedule. Taking the advantage of such technology to overcome the problems leads to the successful completion of a construction project.

- To keep the proper record of construction planning and scheduling.
- To work according to scheduled time in order to avoid delay in the construction project.
- To increase the efficiency of the project by taking advantage of technology.
- To reduce the difference in the scheduled tie and original construction time of the project.

3. LITRATURE REVIEW

Aswin Kumar S., Gopalakrishnan S. [7]. The paper focuses usage of mobile applications on construction sites for proper monitoring of schedules and save time and project budget. The application has the ability to data entry, Upload images, backups; SMS alert for any new uploads. It concludes that using this module construction project saves up to 6.5% of their project expenditure budget. Jordi Carlos Garcia Garcia, David Ardit, Kiet Tuan Le [18]. The paper represents the Mobile application that is Construction Progress Control (CPC). The application prototype was

developed so that the project manager would record the ongoing process on-site, attach photos or evidence and send it to the office to update the schedule. It concludes that the application is improving the efficiency in recording the progress on site, updating on time progress [21]. Norleyz Jailani, Zuraidah Abdullah, Marini Abu Bakar and Harni Rohaida Haron[27]. The paper resembles the usability of Mobile applications in the construction industry. A Mobile application (PACMAD) model was developed. The methodology of the paper contains the content analysis for theoretical study and empirical study which include the interviews of mobile application developers in the construction industry. Dr. Anoop Sattineni, Taylor Schmidt [12]. In this research, interviews were taken to know how they use Mobile phones on construction sites. The paper reveals that mobile tools are extraordinary devices that can be used on construction sites. The capabilities of these devices to link with the internet help the stakeholders so that they can access and share the information easily and in time. Lew Jia Chun [20]. The paper determines the amount of usage of the construction application and also factors affecting the usage on the field. Questionnaire surveys were created and sent in Johor Bahru. About 67 responses were collected and analyses are carried using descriptive analysis by frequency distribution and mean score method. Seong-Jin Kim, Hyun Ok, Tae-Hak Kim [33]. The application was developed for the tasks which are connected with the construction project management system to more perform more efficiently on construction sites. The Application provides detailed inspection, weather forecasting, terminology, contract information, and also site-based photograph information. Changyoon Kim, Taeil Park, Hyunsu Lim, and Hyoungkwan Kim [10]. This paper aimed to develop mobile technology for the on-site management system. There were three main components of the mobile system which were site monitoring, task management, and real-time information sharing. The Application was practiced in a hospital building. The conclusion was made that the mobile application improved the overall performance on-site by advancing the level of communication, Improve quality and data sharing, etc. Mehdi Nourbakhsh, Mohamad Zin Javier Irizarry Samaneh Zolfagharian Masoud Gheisari [22]. The paper represents the prototype of a mobile application for improving management on sites. The information was collected from the perspective of Contractors, consultants and owners. The application reveals the information to owners about the delay, schedules, order change, QC/QA reports. Consults gets the reports of schedule updates, QC/QA reports, accident reports, daily reports, site instructions, and design intend and clarification reports.

Adel Khelifi, Khaled Hesham Hyari [1]. The paper presents the development of a mobile application to ease the communication on construction site, improve the efficiency and timely completion of projects. The application enhances the communication between the office and on-site staff. It allows uploading the photos instantly on-site carries documents, enables to track the progress on-site, and also send reports.

Ales Magdic, Danijel Rebolj [2]. The case study revealed that by use of mobile devices there is improvement in the exchange of information on site. It has two parts the first part defines the concept of mobile computing and the second part experiments the systematic use of mobile computing devices. It declares that mobile computing plays an extraordinary role in the construction industry. Yuan Chen, John M. Kamara[41]. The paper aims to develop mobile computing on-site construction management and communication. The model will explore the concepts between the area of mobile computing and construction onsite management. The application will help the user to select mobile computing strategies. Arabinda Sharma, Dheeraj Gupta [5]. The paper aims at the potential role of smartphones in civil engineering projects. Various roles of mobile smartphones in civil engineering studies are studied in the fields of Surveying and Drafting, Environmental Monitoring, Traffic and Transportation Engineering, Construction site Management, Structural health Monitoring. It concludes that smartphones play an important role in various aspects of civil engineering projects. Smartphones improve accuracy and efficiency, provides field data collection and analysis.

Sitalakshami Venkatraman, Pak Yoong[34]. The paper discusses the potentials of mobile technology in the construction sector in New Zealand. The paper describes the development of a mobile application called ClikiFax. The application can perform in time management on remote construction sites. It was field-tested by 5 construction companies to know its potentials. The application was said to be useful majorly in business processes such as a dynamic change in site drawings, approvals at remote construction sites. Factors considered while identifying the motivators were job factor, environmental factor, and behavioral factor. Sudharsan K., Priyadarshan P. [35]. The paper represents the Mobile Application for supporting construction on-site Management. The application will enhance the proper communication and exchange of information between the onsite manager and office staff at the sites. Vahid Faghihi, Ali Nejat, Kenneth F. Reinschmidt, Julian H. Kang [39]. The paper

shows various scheduling methods, Problems in scheduling and methods are examined to solve them by different tools & techniques. Amir H. Alavi, William G. Buttler[4]. The survey is conducted of existing smartphones based sensing deployments. The applications are surveys related to pavement engineering, structural engineering, traffic engineering, construction engineering and management and also earthquake engineering. The paper collects a literature review of various mobile applications related to infrastructure monitoring. David Leicht, Daniel Castro-Fresno, Joaquin Diaz and Christian Baier[11]. The paper discovers the existing applied scheduling tools to know their potentials. Through the application of 5D-PROMPT method, a case study was performed to obtain an overview of the improvements in the project scheduling, planning, and budgeting. Asmaa Atef, Mohamed Abdel-Baset, Ibrahim El-henawy [6]. The paper contains a review of project scheduling problems. The paper concludes that the scheduling of every project varies, and each project has its section scheduling characteristics. Bahadir V. Barbarosoglu, David Arditi [8]. The paper discusses the Mobile applications available in the construction industry and its functions. Study defines that the use of devices such as mobile phones enhances the workability with real-time increasing productivity. It concludes that there are two methods in adopting mobile applications that are to identify the need to develop applications and utilization of available applications as per the needs.

There are lots of mobile applications developed in the market which are used according to the needs of the user. These applications help to improve work more efficiently and to provide its best service on construction sites. Mobile Devices applications have taken up the majority of jobs such as scheduling, planning, 3D structure analysis, estimating costs of projects, Maps, tape measure, calculator, Documentation, Digital cameras, Notebooks and notepads, record maintenance, weather determination, Data management and data storage and many more. Construction Industry now relies on such Mobile device applications and software to complete Construction Projects [38] [42].

4. METHODOLOGY

Effective project planning needs to maintaining at construction schedule which is critical, but not maintained [4]. This is because the large parts of the planning are dependent on manual methods which are tedious, time-consuming which prone to error also it becomes impracticable for contractor to maintain hand notes [5]. In such a rough construction environment compactable,

portable and lightweight devices such as Mobile phones or tablets appear to be more suitable [37]. Work of Schedules supports the contractor to pinpoint the subsequent work needed to complete the works and to estimate the time required for that work. As a consequence, schedules of work must properly describe every significant item of work to which they relate.

The Project MasterPlan Mobile Application works on uploaded planned schedule. As before starting of any project proper planning is carried out. This planning is to be uploaded in the application. Details which are related to the work are to be uploaded such as task name, date and time required for particular work. The specialty of the application is it notifies the user about the work that is to be completed early depending upon the schedule. This notification acts as an alert /warning to complete the task within the set date. User has to upload all the details and also date and time for notification. The application will give the alert alarm in advance. This will help the contractor to know the days remaining for the on process task. The aim of this mobile application is to allow the manager site to record the status of the ongoing activity onsite. It also allows the manager to attach photographs of work, take notes, and evaluate the project progress by progress report generate by the application.

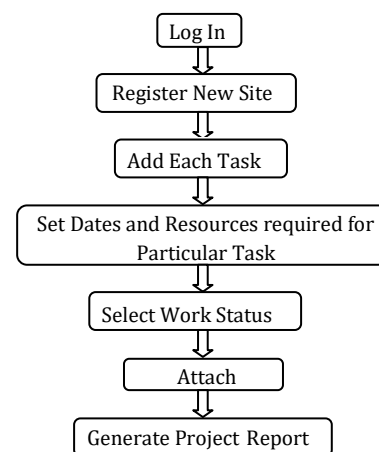


Fig- 1: Flow Process of Mobile Application

5. RESULT & DISCUSSION

Mobile application is not a new concept in Construction Industry. Usage of Mobile devices for various jobs is common solution for easy completion of work. The only point to consider is the proper use and implementation of advance technology for the progress and successful completion of the construction project. There are several ways for implementation of various techniques for mobile application.

Each application has various features according to the requirement. Every application has its own advantages and disadvantage which depends upon the application of user.

The Mobile Application presented in the paper was developed for Android devices. The programs of the application are coded that support only android devices. Hence, the developed mobile application can work only on android system devices. During the development of the mobile application care as taken that the application would provide the wholesome utilization for the user. The Mobile Application was applied on a site to know its proper usage in order to avoid doubts in future.

5.1 Overview of Project MasterPlan Mobile Application

The Mobile Application has various features which are used during the usage of the application on Construction site.

1. Application Page



Fig- 2: Mobile Application Logo

The Mobile Application for Scheduling is titled as “Project MasterPlan- Planning, Labour & Equipment”. The Application consist the details of planning of project uploaded in it with its Labour and Equipment required for each work.

2. Log in Page

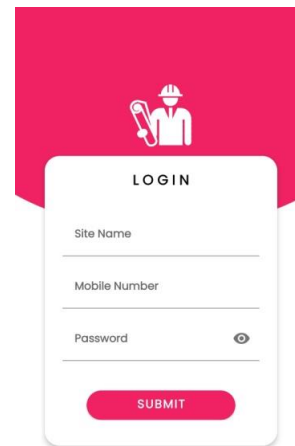


Fig- 3: Application Log in Page

The user has to login to access into the application. User need to enter the Site Name, Mobile Number and the authenticated password. The application provides secure access for the entry. This provides data protection. Only the user having Id and password can login into the application. After entering the accurate user d and password and submitting it the application allows user to access the application.

3. Control Desk



Fig- 4: Application Control Desk

This is the Control page of the application. It provides a progress way to use the application. One has to register the new site in order to work scheduling in this application. It

allows user to create new site by using the “Site Register” option at right bottom corner of the page.

4. Site Registration

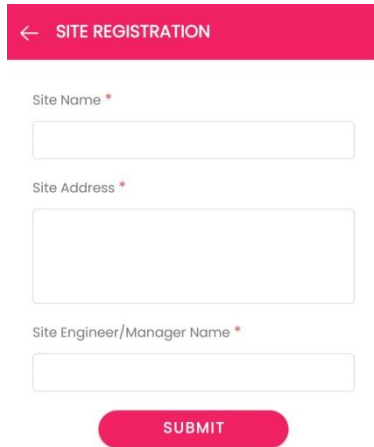


Fig- 5: Site Registration Page

Site Registration is done to create a new site/project in the application. Fill the information about the site that is to be created. Information required to create a new site is Site Name, Address of the site and the authority person handling the site. After submitting the required details of the site new site is created. Site Registration is important as all details of the task carried on site are displayed in particular site.

5. Project List

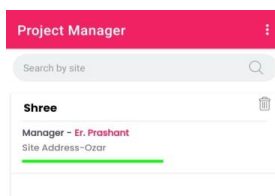


Fig- 6: Project List Page

The paper display the list of all the projects registered in the application. The list provides some details of the project such as Name of site, Address of site, same of site manager, status of the project. Application allows user to delete the

site if needed. The page is provided with search bar to search project by its name. User can register new site on the same page.

6. Add Task

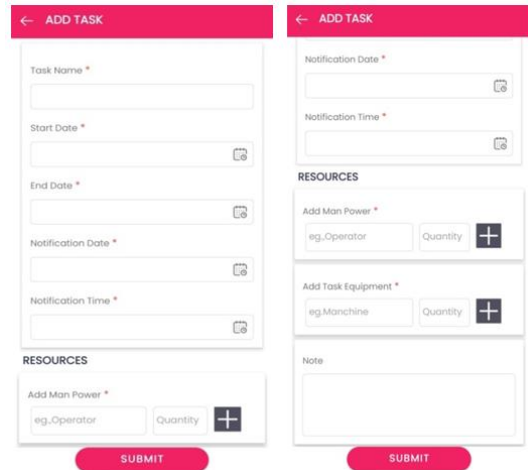


Fig- 7: Add Task Page

After registration of a new site in the application user has to add the task within the same site to list down the schedule. Page No.1 shows list of details needed to add task. For addition of new task user has to upload task name, Start date of the task, estimated end date. User has to select notification date and time so that the application will give the alert notification on the selected date & time. Page No.2 shows details required to be filled related to resources. Users also have to upload resources required for each task. Resources such as manpower required for the task and equipments have to be uploaded. Application proved the user to add some notes for every task if needed.

7. Task List

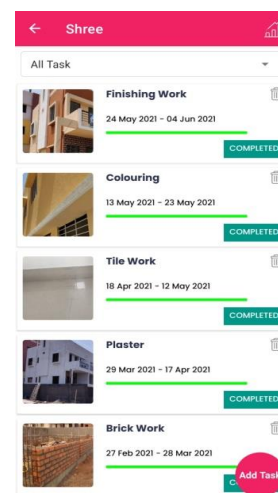


Fig- 8: Task List Page

After creating the new task it is displayed in the task list page. Heading of the page displays the name of the site within which the tasks are added. The list shows some details of the task such as name of task, start date and end date of task, status of the task, photo attached of every task. Status bar shows different color according to the progress of the work. Completed task shows green color of status bar in the task list. Application allows the user to delete the task if needed or edit the task if any corrections. The same page allows user to add new task within same project. Application generates a report based on task performance. Report can be obtained by option provided at the right top corner of the page. The status of each task can be updated according to the progress of the work.

8. Task Details

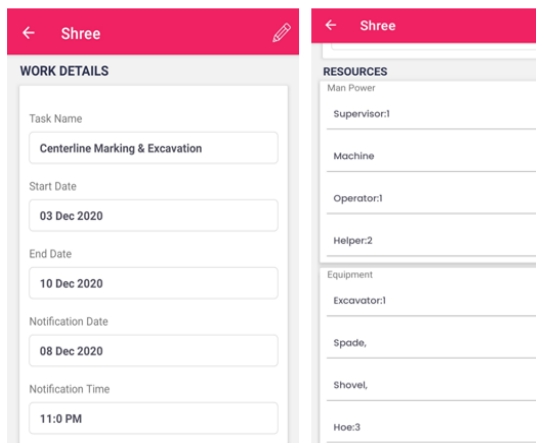


Fig- 9: Task Details Page

The page displayed all the details of the task which is uploaded during add new task. The details are divided in two sections that are Work Details and Resources. Each section shows the details of task accordingly. Work Details shows the name of task, dates related to particular task along with time. Resources section is again divided in two parts. First is manpower and second is equipment. The manpower required for that particular job are listed under manpower section and equipments required for the same task are listed under equipment section. Application allows the user to edit work details is necessary.

9. Task Filter

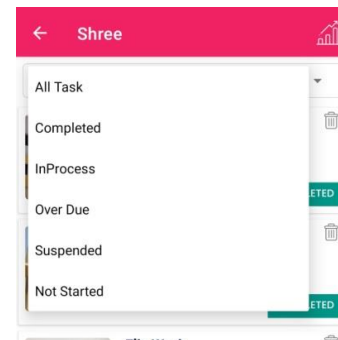


Fig- 10: Task Filter Page

List of task is combination of various tasks and each task has different status according to the progress. Application allows user to filter the task according to need. Task can be filtered by the status of the process. Using the dropdown option provided at the top of the page allows the user to filter the task as per need. Task can be filtered by status of completion such as Completed task, inprocess task, Overdue ask, Suspended task and task which are not started yet. This option allows the user to easily get the details of list of task of similar progress.

10. Update task Work

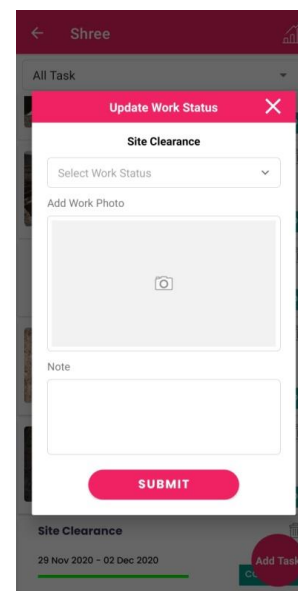


Fig- 11: Update Work Process Page

Each task within the project has different work status. User has to set the status of work as completed, in process, overdue, suspended and not started. Application also allows the user to attach photos of particular task. This behaves like

an evidence of completion of the task. Note if any of the particular task can be noted.

11. Notification Message

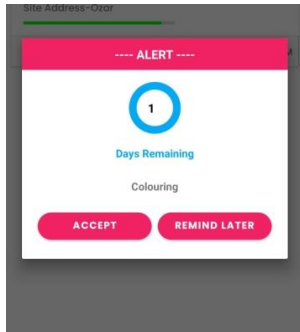


Fig- 12: Notification Message

The application shows the notification alert message of the task that the end date is near. Notification is given according to the set date and time during the adding the task. The alert message displays the days remaining for completion of the task, name of the task. This gives the user warning to complete the task as soon as possible to complete the project within deadline and to avoid delay.

12. Final Reminder

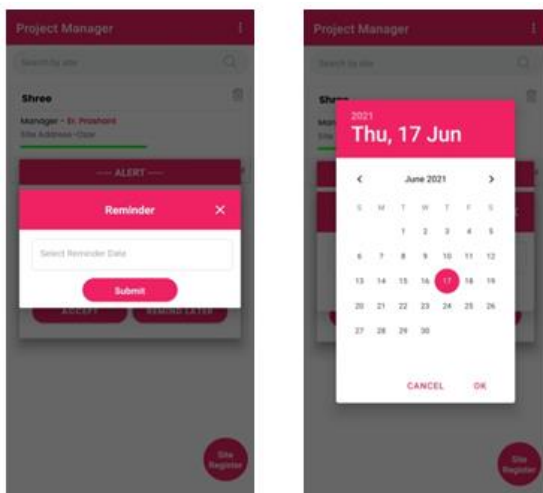


Fig- 13: Final Reminder

When the notification is displayed it gives two options. First option is to accept the alert message and immediately work on it and second option is to reset the reminder. Remind me later option gives the user second chance to select the date for next reminder. After resetting the date the application will notify according to the next set date.

13. Work Report

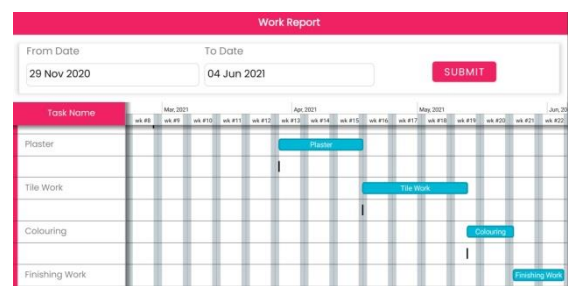
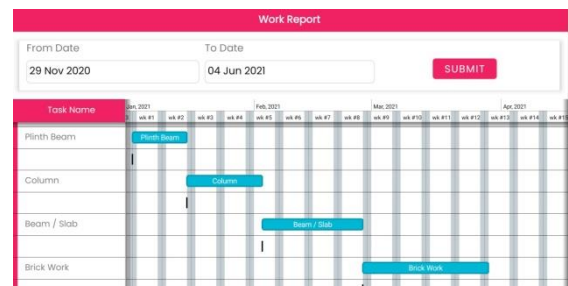
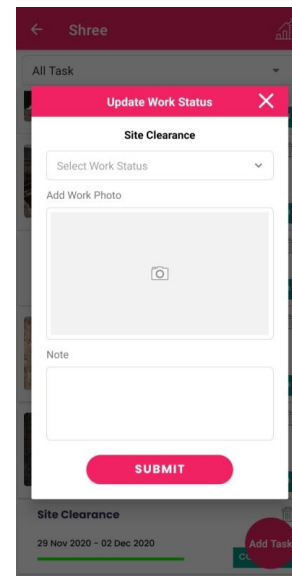


Fig- 14: Work Report

After the completion of the project according to Mobile Application, the application generates the report of particular project for reference. The report is presented in Gantt chart. Start date and end date of the project is to be selected and

after submitting the dates the application generates the report in the form of Gantt chart. This will provide the user to know the delay occurs if any and overall progress of the project.

14. Log out

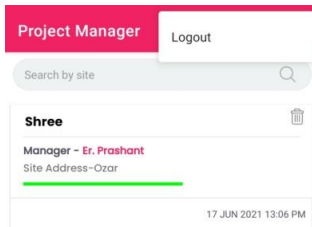


Fig- 15: Log out Page

The Application allows the user to login from the application if needed and can again log in by authenticated user id and password. This promotes security for the data entered.

5.2 Comparison of Project Schedules

Case study of the construction site, comparing the completed project by Mobile Application and with the traditional method of scheduling in the Construction Project.

Table 1: Schedule of Project by Mobile Application

Project Start Date	Project End Date	Project Duration
29/11/2020	4/6/2021	187

Table 2: Schedule of Project by Traditional method

Project Start Date	Project End Date	Project Duration (In Days)
29/11/2020	18/6/2021	201

Table 5: Comparison between schedules of project by Mobile application and traditional method

Project Duration with Traditional Method (In Days)	Project Duration with Mobile Application (In Days)	Duration Difference (In Days)
201	187	14

Thus, the project completed with the help of Project MasterPlan Application completes the project 14 days earlier

than the project completed in traditional method that is without using the Mobile Application.

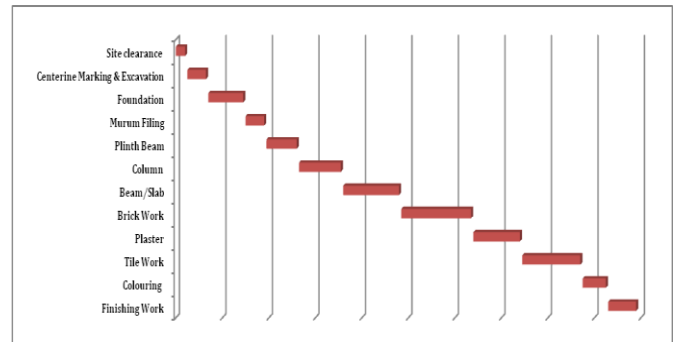


Fig- 16: Gantt Chart of Schedule of Project by Mobile Application.

6. CONCLUSIONS

Construction projects mainly lack in timely completion of project [40]. Mobile application can guide to work according to scheduled plans to avoid delays. Time remaining for the ongoing work and time for next work is known. As the application contains all the scheduling information tedious writing work can be avoided on site. Just set the schedule in the application and you are free to go!

Information is known in prior, progressing work preplanning are made which improves the performance of the project and increases the efficiency of construction work. The application is able to save the images of the work that is completed as a proof of completion of work. The application can be prove as a better use of technology in construction Industry.

The application provides notifications which support the manager to work on time and gives the presence of time on site for the particular task. Thus, helps to avoid delay and rework. As the next task and time remaining for the next task is know in advance this allow manager to prepare for the next work. Preparations and planning can be made prior of starting of the work so it reduces the wastage of time during the working of the task.

The mobile application allows user to work on multiple project simultaneously. One can track the progress of the multiple projects at a sight. As the application allows attaching photos of task which records the progress and acting as an evidence of actual work. The application generates the final report of the project automatically. Using this application on site proved that it saves time. According to the case study about 14 days the project was completed with the help of the application. Thus, the application can prove as a better utilization of technology in the construction world.

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