# DEVELOPMENT OF

# AUTOMATED RESOURCE MANAGEMENT SYSTEM (ARMS)

**Final Year Project (2018-19)**

By:


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Islamabad, Pakistan


(2019)

# CERTIFICATION

This is to certify that thesis entitled

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Has been accepted towards fulfillment of the requirements

**For Bachelors in Civil Engineering**

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# ABSTRACT

Construction industry is considered efficient when there is no time and cost overuns in the project. Construction industry has been using technology for different processes but there still space available for improvement. Construction industry in Pakistan is relying heavily on manual site management and paperwork for documentation.

The idea behind this project is to automate the resource management system of our construction sites. Factors causing problems (cost and time overrun) due to improper resource management were identified from literature and previous researches. These factors were then analyzed using questionnaire and visiting different construction sites.

After identifying and analyzing the factors, a framework for automated resource management was developed which included solution to different problems identified and planning for working of mobile application. It included planning for the data and information availability to every user based on hierarchy and information flow procedure of construction sites.

Along with the planning part, a user-friendly mobile application was be developed which aims to reduce the inconvenience by integrating features that allow users to request materials, request machinery, check availability of machinery, check status of their request, view their activity log, make request to higher authorities for procurement from outside source and register any complaints/suggestions one might have.

ARMS provide an economically viable, socially acceptable and environment friendly resource management system which will help reduce time and cost overruns of construction industry and improve the efficiency of construction industry.

# DECLARATION

It is hereby solemnly and sincerely declared that the work referred to this thesis project has not been used by Any othe university or institute of learning as part of another qualification or degree. The research carried out and dissertation prepared was consistent with normal supervisory practice and all the external sources of information used have been acknowledged.

# DEDICATION

We would like to dedicate our work to our parents. It is because of only them; we have come this far. They have always been there for us. Whenever we needed their help of any type, they never denied us.

We would also like to dedicate our work to our teachers. Their sincere and professional guidance helped us grasp the knowledge of engineering and they are the ones due to whom we fulfilled our dream of being an engineer.

# ACKNOWLEDGMENT

We thank The Almighty Allah for giving us the strength and belief in ourselves for undertaking this final year project. We also take the opportunity to express our gratitude and respect to our parents, without whose prayers and wishes we would never have been able to come this far in our project.

It is utmost necessary to acknowledge and thank our advisor and mentor Lecturer Muhammad Hasnain, for all his admirable guidance, assistance and motivation provided throughout our project. It is with his support that we have been successful in achieving our objectives. We would also like to appreciate the guidance offered by our HoD CE&M Dr. Jamaluddin Thaheem, which in fact helped in culmination of this project.

We would also like to mention and thank all those departments, construction companies and construction professionals who provided us with their time, assistance and data. Without their cooperation this project would not have seen the light of dawn.

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*Chapter 1*

# INTRODUCTION

## 1.1 BACKGROUND

Efficiency of construction industry is always considered as on-time delivery of construction project with no cost over-runs(Bowden, Dorr et al. 2006). Many research reports show a positive relation between technological advancement and efficiency in different industries. In the case of the construction industry not much research has been carried out.

In order to improve project delivery, the construction industry is forced to incorporate new advanced technology in the construction process. Because of the fact that technology use is still uncertain in the construction industry, it is a challenge to incorporate new technology. Besides this construction industry never changed with the ever-changing nature of technology.

Proper communication and automated monitoring systems can help in increasing efficiency of our construction industry (Xinhai-lu, 2011 #25). Lack of good communication mechanisms, ineffective reporting system and Lack of adequate data channels are some of the reasons why the construction industry has lower productivity and poor performance.

In addition to this language skills, listening skills, emotional interference and physical barriers have proved to be problem in communication. On our construction sites, people from different linguistics communicate with each other. Sometimes this is a major problem and there should be a uniform system to overcome these barriers.

## 1.2 IMPACT OF INFORMATION TECHNOLOGY

As stated earlier, cost over-runs, time over-runs and poor communication are major problems in our construction industry. Developments have been made in this respect as construction industry has adopted modern tools like design software in place of manual drafting and drawing, software instead of manual cost estimation and planning but there is still room left for further development(Bowden, Dorr et al. 2006). Use of ICT and technological innovation can help in following ways:

- Reducton in contruction tim

- Redution in cos of contruction
- Increase in productivity
- Redution in operation cost
- Reduction in waste

## 1.3 PROBLEM STATEMENT

Construction industry in Pakistan is relying heavily on manual work for technical purposes and paperwork for documentation. Information through conventional channels gets dissipated easily thus causing loss of material, delay in material delivery, extra cost and lower productivity. This project aims to provide a properly planned, real-time, automated resource management system.

## 1.4 OBJECTIVES

Construcion indstry bing one of the largest indstries has a major contribution in country's economic growth. With incorporation of information technology in different industries is forcing construction industry to use information technology. Construction industry has incorporated information technology in different portions of industry but there is still room left for improvement when it comes to resource management. An automated, user friendly and sustainable resource management is a viable option to improve the current system. Development of Automated Resource Management System (ARMS) went through following objectives:

### 1.4.1 Problem Identification

Construction sites are complex in nature when it comes to management and record keeping posing a big challenge for project managers. The already existing system of communication, resource management and record keeping lacks presence of automation which leads to reason of its inefficiency. In order to induce planning and meeting this core objective, following should be followed.

- To identify factors causing problems (i.e. cost and time over-runs) in construction resource management using previous researches.

- To analyze these factors on real life construction projects.

### 1.4.2 Designing Framework

After identification and analyzing factors causing problems in resource management, second objective was to design a framework providing solution to all the problems identified in first step. this framework not only provided solution to problems but also used in development of mobile application which is next objective. So, the second objective is:

- To develop a soltion for the identified problems.
- Design a framework incorporating the proposed solution for real-time resource management.

### 1.4.3 Mobile Application

The third objective is development of mobile based user-friendly application which can be used to order material and machinery from on-site construction yard/store, confirm reception of material/machinery, keep record of available material/machinery, notify concerned personnel to procure material on time. So, the third objective is:

- Development of mobile based application in order to:
  - Request and check availability of construction machinery.
  - Request and keep record of available material.

*Chapter 2*

# LITERATURE REVIEW

## 2.1 INTRODUCTION

Resource planning and management is one of the most important factors for profitability and competitiveness in today's construction industry. Efficient utilization of equipment and material can help reduce costs and time incurred in the project.

Building materials and installed equipment may represent 50-60 percent of a typical industrial project's total cost. The handling of material and components has a direct impact on the performance of the project. Hundreds of materials are used in construction projects through design, manufacturing, interim processing, delivery and storage before installation is scheduled. Planning materials installation requires team foremen to check materials availability and other requirements (Durdyev, Omarov et al. 2017).

Construction industry has gone through leaps and bounds throughout the process of development. From introduction of construction machinery to introduction of IT software like AutoCAD, Primavera and many other design software have given our construction industry a great boast. Still efficiency and productivity of construction industry can be improved. Construction sites lack proper communication mechanisms and efficient and automated method of monitoring resources.

Average of time over-run is between 10-30% of original duration according to 76% of contractors while same was agreed to by 56% of consultants.(Assaf and Al-Hejji 2006). Lack of effective communication and material shortage along with improper planning caused delays in construction projects. (Moon, Xu et al. 2018).

In practice, poor resource management cause schedule slippage along with cost overruns(Li, Chan et al. 2016). Tasks competing for limited resources of same project increase complexity of activities (Pinha and Ahluwalia 2018). US National Research Council (NRC 2009) stated that to improve competitive nature of construction industry, the project schedules, labor, material, and energy costs should be managed effectively.

Relation between resource management to time and cost over-runs have been studied by many researchers. All of these researches identified more or less same problems. These problems are enlisted below and are categorized with respect to different involved parties(Tserng, 2012 #24).

### 2.1.1 Factors Causing problems in Construction industry

Different research papers were read and most common factors causing problems are as under:

| | Factors | References |
|---|---|---|
| **CLIENT RESPONSIBILITY** | Change in the scope of the project | Mahamid (2011), Abedi et al. (2011a), Hamzah et al. (2011), Fugar & AgyakwahBaah (2010), Yang & Wei (2010) |
| | Delay in progress payment by owner | Smbasivan & Soon (2007), Alaghbari et al., (2007), Enshassi et al. (2009), Le-Hoai et al. (2008), Mahamid (2011), Abedi et al. (2011a), Hamzah et al. (2011), Fugar & Agyakwah-Baah (2010) |
| | Financial difficulties of owner | Mahamid (2011), Hamzah et al. (2011), Fugar & Agyakwah-Baah (2010), Le-Hoai et al. (2008), Yang & Wei (2010), Smbasivan & Soon (2007), Alaghbari et al., (2007 |
| | Delays in decisions making | Mahamid (2011), Abedi et al. (2011a), Hamzah et al. (2011), Yang & Wei (2010), Smbasivan & Soon (2007), Alaghbari et al., (2007), |
| | Owner interference | Abedi et al. (2011a), Smbasivan & Soon (2007), Enshassi et al. (2009) |
| | Unrealistic contract duration and requirements imposed | Mahamid (2011), Smbasivan & Soon (2007), Yang & Wei (2010) |

| | | |
|---|---|---|
| **CONSULTANT RESPONSIBILITY** | Delay in inspection and approval of completed works | Fugar & Agyakwah-Baah (2010), Smbasivan & Soon (2007), Alaghbari et al., (2007), Enshassi et al. (2009), Le-Hoai et al. (2008) |
| | Unrealistic contract duration and requirements imposed | Mahamid (2011), Smbasivan & Soon (2007), Yang & Wei (2010) |
| | Frequent design changes | Mahamid (2011), Smbasivan & Soon (2007), Le-Hoai et al. (2008), |
| | Mistakes and Errors in design | Mahamid (2011), Fugar & Agyakwah-Baah (2010), Enshassi et al. (2009), Le-Hoai et al. (2008), Yang & Wei (2010) |
| | Delay Preparation and approval of drawings | Smbasivan & Soon (2007), Alaghbari et al., (2007), Enshassi et al. (2009) |
| | Incomplete design at the time of tender | Mahamid (2011), Alaghbari et al., (2007), Yang & Wei (2010 |
| **CONTRACTOR RESPONSIBILITY** | Inadequate planning and scheduling | Hamzah et al. (2011), Fugar & AgyakwahBaah (2010), Smbasivan & Soon (2007), Yang & Wei (2010) |
| | Lack of experience | Abedi et al. (2011a), Hamzah et al. (2011), Fugar & Agyakwah-Baah (2010), Smbasivan & Soon (2007), Alaghbari et al., (2007), Enshassi et al. (2009) |
| | Poor site management and supervision | Hamzah et al. (2011), Fugar & AgyakwahBaah (2010), Smbasivan & Soon (2007), Alaghbari et al., (2007), Enshassi et al. (2009), Le-Hoai et al. (2008 |

| | | |
|---|---|---|
| | Incompetent subcontractors | Abedi et al. (2011a), Hamzah et al. (2011), Fugar & Agyakwah-Baah (2010), Smbasivan & Soon (2007), Alaghbari et al., (2007), Le-Hoai et al. (2008) |
| | Cash flow and financial difficulties faced by contractors | Mahamid (2011), Abedi et al. (2011a), Hamzah et al. (2011), Alaghbari et al., (2007) |
| | Mistakes during construction | Mahamid (2011), Hamzah et al. (2011), Smbasivan & Soon (2007), Alaghbari et al., (2007), Enshassi et al. (2009), |
| **RESOURCE RELATED FACTORS** | Fluctuation of prices of materials | Mahamid (2011), Le-Hoai et al. (2008) |
| | Shortages of materials | Mahamid (2011), Fugar & Agyakwah-Baah (2010), Smbasivan & Soon (2007), Alaghbari et al., (2007), Enshassi et al. (2009), Le-Hoai et al. (2008), |
| | Late delivery of materials and equipment | Fugar & AgyakwahBaah (2010), Alaghbari et al., (2007), Enshassi et al. (2009) |
| | Insufficient Numbers of equipment | Hamzah et al. (2011), Smbasivan & Soon (2007), Alaghbari et al., (2007), Enshassi et al. (2009) |
| | Labor Productivity | Hamzah et a (2007), Alag et al. (2009) |
| | Shortage of site workers | Abedi et l. (2011), Fuga Alaghbari et al. (2009 |

## 2.2 BENEFITS OF INFORAMTION & COMMUNICATION TECHNOLOGY

Continous access to information, enhanced information to support decision-making, increased financial control and communication, easier and faster access to common data and reduced documentation errors are all the benefits of using Information and Communication

Technology (ICT)(Sardroud 2014). Project managers often lose the ability to manage change with traditional communication tools.

ICT integrates the communication amongst different departments and sub units of a construction organization and also delivers rapidity of data into the information system(Sardroud 2014). This would help in reduction of the time and labor used for accessing information about construction process and minimizes the chances of ineffective decision making due to absence of information(ASCE, 2010 #1).

### 2.2.1 Automated data collection devices (ADC)

Automated data collection devices (ADC) are always improving and are being used in logistics and manufacturing industry and can improve construction job sites(Sardroud 2014). According to (Irizarry, Karan et al. 2013), increased efficiency, reduced data entry errors and reduced labor cost can be achieved by using ADC technologies (Sambasivan and Soon 2007).

The development of affordable mobile technologies has made it possible to deploy them in all industrial and commercial sectors. Weekly shopping to a hospital consultant revisiting record of patient using a PDA has proved the effectiveness of mobile technology(Ahuja, Yang et al.

2009). Interest in the potential application of PDA in the construction process is increased due to their improved performance and reduced prices.

Different users can be connected on sites using PDAs and on site operations can be managed effectively. This type of Communication will reduce time and cost incurred by

construction projects(Kasim 2015). Time to access information, time to check activity, reduction in number of lost items, material tracking system, alerts, material shortage alerts and many different factors reduce time and cost of construction projects(Memon, Rahman et al. 2014).

## 2.3 FUTURE PROSPECTS

A technology roadmap has been developed by a non-profit consortium namely Fully Integrated and Automated Technology for Construction (FIATECH) in which the particular interest is the "Intelligent and Automated Construction Job Site" and the "Integrated Automated Procurement and Supply Network" including following ideas of the future:

- On site Tracking of materials, equipment, personnel and other resources.
- Construction workers perform their jobs quickly and correctly as they are provided with technology and knowledge about project.
- The site tracking system will help in managing daily construction progress by continuous flow of materials.
- Enabling workers to instantly locate the resources they need and get them delivered for immediate use.

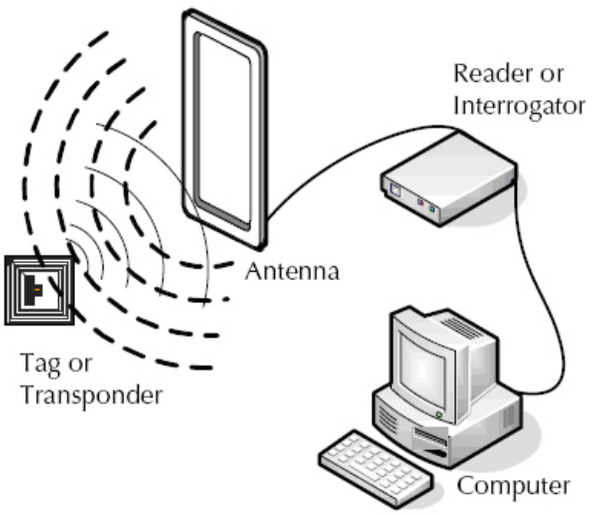
## 2.4 MOBILE APPLICATION

Processes on construction sites are managed through calls and manual record keeping is employed to store data making it difficult to manage and keep track of activities. Also, the personals on construction sites i.e. site engineers do not get any information about the progress on their request. Moreover, the project manager or higher authority find it difficult to track and keep an eye on their inventory. The automated resource management system mobile app aims to reduce this inconvenience by integrating features that allow users to request materials, request machinery, check availability of machinery, check status of their request, view his activity log, make request to higher authorities for procurement from outside source and register any complaints/suggestions one might have.

### 2.4.1 Radio-Frequency Identification (RFID)

Radio-Frequency Identification (RFID) uses radio waves to access information stored on an object tag. A tag can be accessed several feet and there is no need for direct line-of-sight. RFID is one method of automatic identification and data capture (AIDC).

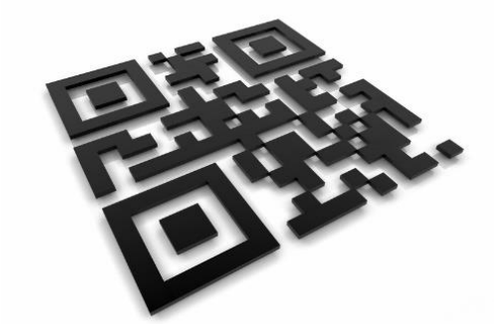
RFID tags are used in many industries. For example, an RFID tag attached to an automobile during production can be used to track its progress through the assembly line,




pharmaceuticals can be tracked through ware houses and implanting RFID microchips in livestock and pets enables positive identification of animals.

### 2.4.2 Quick Response (QR) Codes and Scanners

Quick Response Code is a type of two-dimensional barcode. It is a machine-readable optical tag that contains information. QR codes often contain data that points to a website or application. It uses four standardized encoding modes (numeric, alphanumeric, byte/binary, and kanji) to store data efficiently.



Thanks to its fast readability and greater storage capacity, this system became popular compared to standard universal product code (UPC). Product tracking, item identification, time tracking, document management, and general marketing are all the applications of this system.

*Chapter 3*

# METHODOLOGY

## 3.1 GENERAL

The methodology adopted to develop an automated resource management system is based on communication planning and a user-friendly mobile application. The objective of the communication planning was to reduce time consumed in manual record keeping, requesting required material, requesting required machinery and keep an eye on the available resources while the mobile application was developed for the users to interact with system and perform all the activities using this mobile application.

## 3.2 COMMUNICATION PLANNING

Following are the basic elements for communication planning and planning resource management and monitoring:

### 3.2.1 Factors Identification

Effect of construction resource monitoring on project cost and time were studied. A number of research papers were studied to identify factors and parameters relating cost and time of project with resource monitoring. The factors identified are mentioned in literature review. Now the task was to shortlist the factors solely relating resource management to time and cost overruns.

List of factors shortlisted is as following:

- Miscommunication
- Misinformation
- Extensive paper use
- Difficult record keeping
- Misplaced materials
- Shortages of materials
- Late delivery of material and equipment
- Non-availability of equipment and material

- Delay in material procurement
- Lack of communication

### 3.2.2 Questionnaire

A detailed questionnaire was prepared and different construction sites within twin cities (Islamabad-Rawalpindi) were visited. This questionnaire was used to identify how technology push can help eradicate problems regarding resource monitoring systems currently being used on our construction sites.

This questionnaire helped identify need and willingness of professionals to use an automated system for resource management. Other than this questionnaire helped in shortlisting critical factors effecting resource monitoring and management on our construction sites. This questionnaire also included movement details of different types of resources i.e. materials and machinery.

Proper communication channel and standard operating procedure was identified. For example, how a material or machinery request is initiated, how it is processed and how it is delivered. Other than this different problems and delays were observed that are caused due to the communication system.

The survey questionnaire consisted of questions which were divided into various parts. Questions about different parameters were asked including:

- Onsite Material requests
- Onsite Machinery requests
- Procurement
- Communication
- Automation

The questionnaire was designed incorporating all the identified factors causing time & cost over runs.

### 3.2.3 Site Survey

A comprehensive survey was conducted at multiple construction sites of the twin cities. To carry out the survey, a detailed questionnaire and proper sample size selection was required. the questionnaire is discussed in the above lines. Sample size calculator developed by Creative Research Systems was used to calculate sample size survey software (Tserng, 2012 #24). Sample size of 72 was Selected. Confidence interval and confidence level are two main factors which affect the results. Confidence level shows the surety of results in terms of percentage mostly researchers use 95%. Confidence interval is the expected deviation from results.

### 3.2.4 Designing the Framework

The critical factors identified after the survey were used as an input to design an efficient framework. This framework will include planning information flow channels, requesting required machinery, information flow about availability of construction machinery, requesting construction materials and keeping record of available material in construction yard.

This process also involves planning different types of modules. Modules follow some limitations that were planned according to operating procedures and hierarchy. The information shown to the user was according to his position in hierarchy. Following are the basic types of modules that were planned along with the information available to each of the portals.

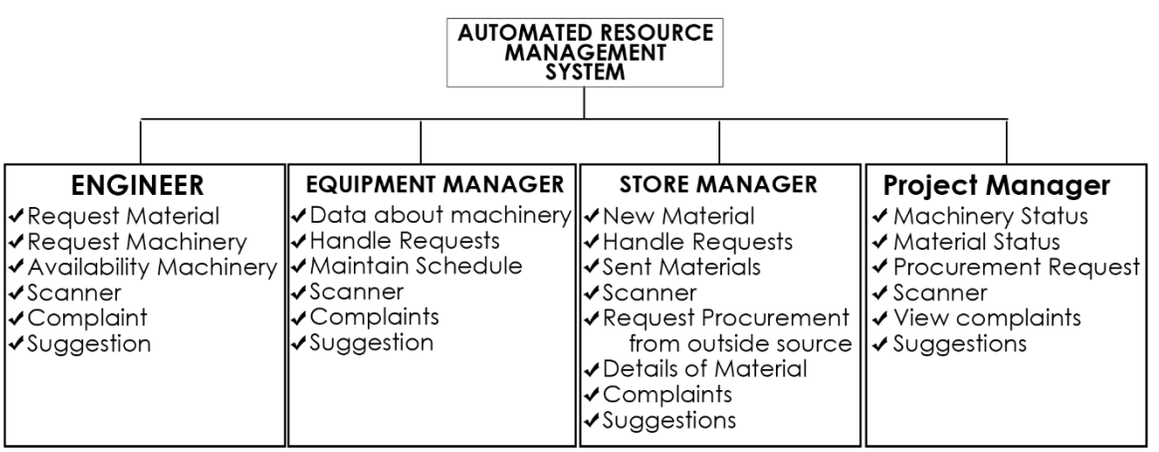



Figure 3.1: A representation of activities one can perform based on his post in hierarchy of organization

Mobile based data acquisition, integrating QR code to mobile application for automatic data capturing, centralized access to project data, mobile based order/delivery method and mobile based notification system helped in providing automated solution to problems identified in the problem identification process of this project.

## 3.3 MOBILE APPLICATION

In order to make the service more compatible with the user, a user-friendly mobile application was to be introduced. The framework and solution designed above were input to the mobile application development process. Mobile application consists of two major process namely communication module and monitoring module.

Communication module includes different types of modules. Each type of module has its own limitations in terms of communication, monitoring and supervision, and requesting for resources. Each module has limited access according to its level in communication hierarchy. It is to be used for the daily reports to which every concerned person will have access and will have a constant update throughout the project.

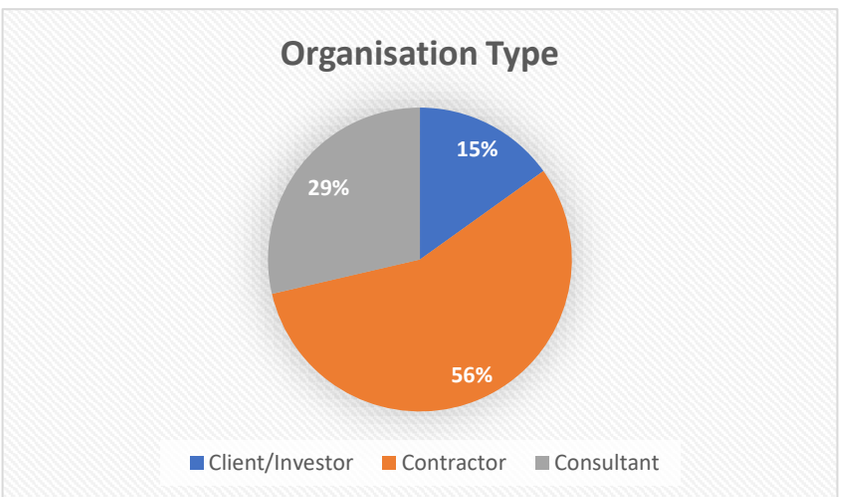
Monitoring module includes different kind of portals which not only monitor the resources but will also be used for requesting materials or required machinery before time hence decreasing delay time. Along with that this module will handle record keeping process for construction materials and calculate quantity of remaining material available in construction yard.

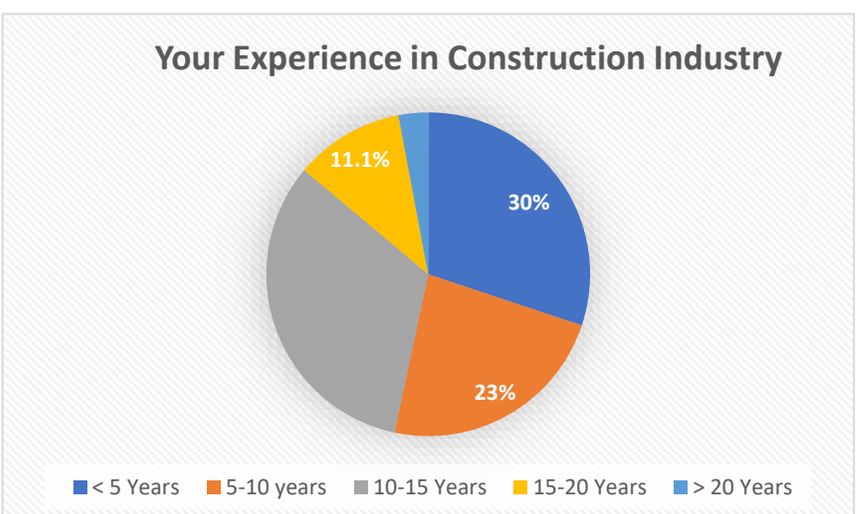
*Chapter 4*

# RESULTS

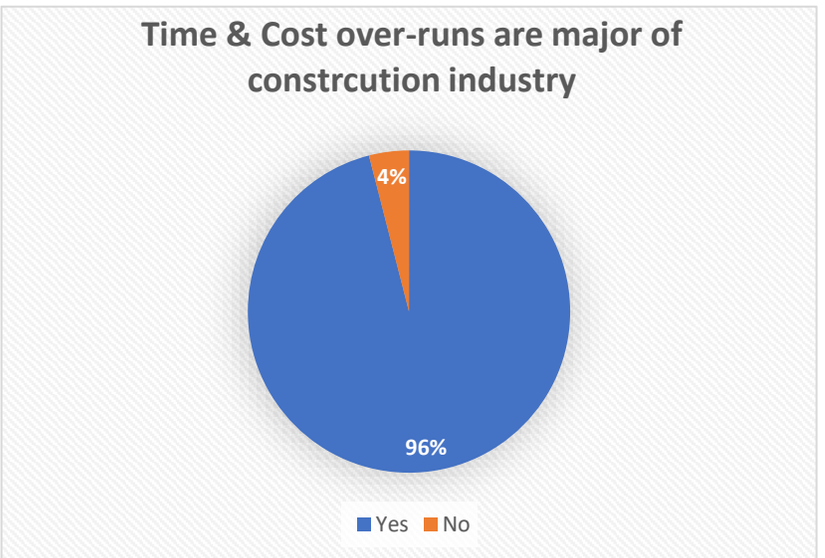
## 4.1 SURVEY RESULTS

A survey was conducted to analyze the factors causing problems in resource management on our construction sites. Survey questions were focused to get the insight about the depth of problem and identify root cause of the problem. Survey results are as follows:

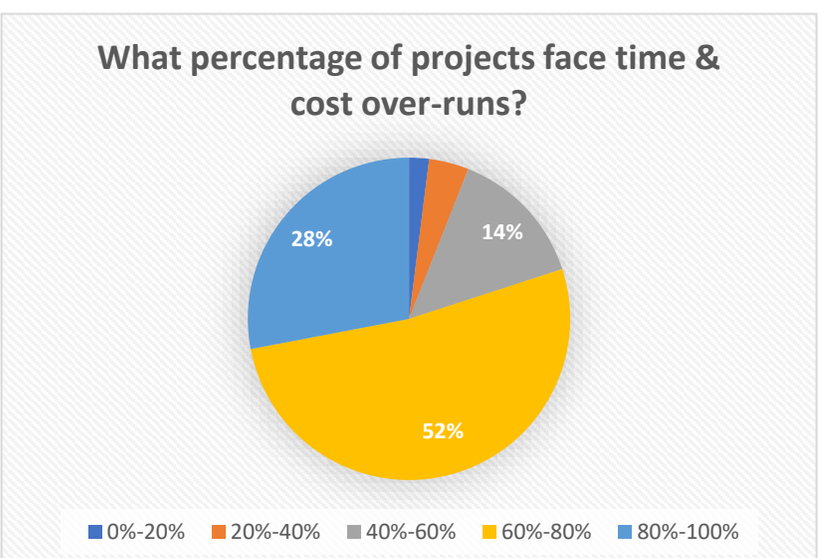



Second most important question was to establish the experience of the person filling the form. As expected, mostly responses were from experienced construction engineers.

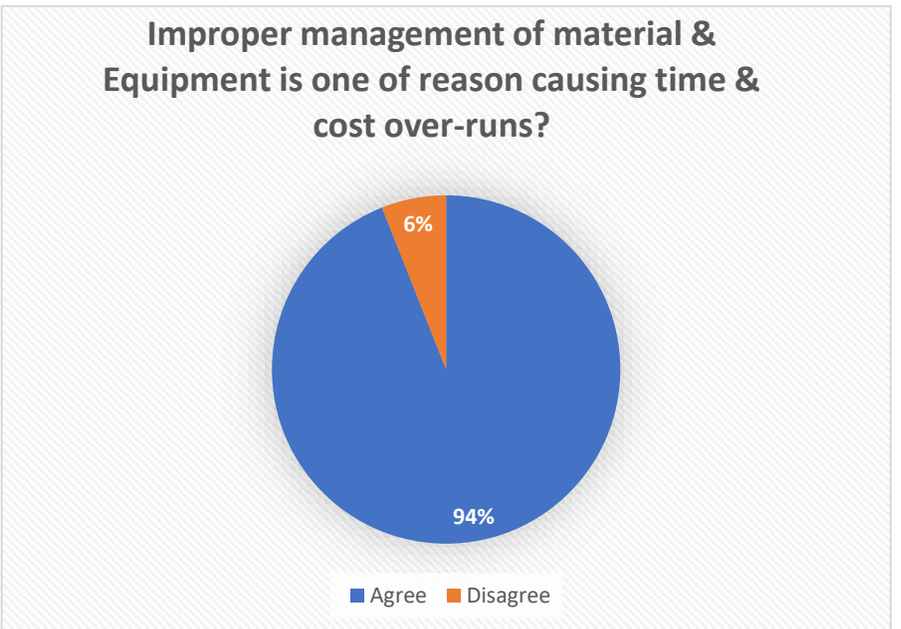



One of the most important questions was whether time and cost over runs were major problems of construction industry and as expected almost all of the people agreed to this statement.

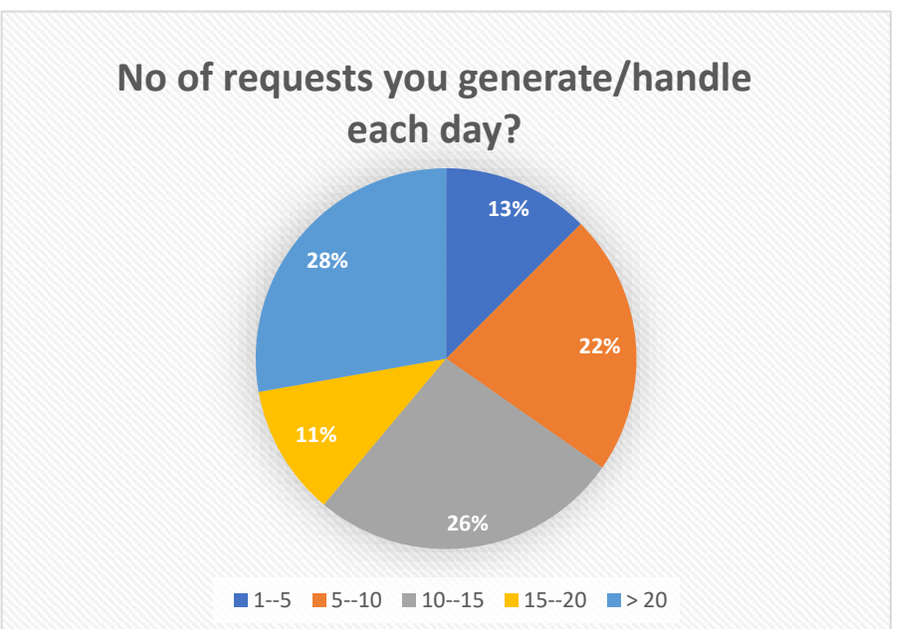



Almost half of the personnel agreed that normally construction projects face delays 80-100% of the time.

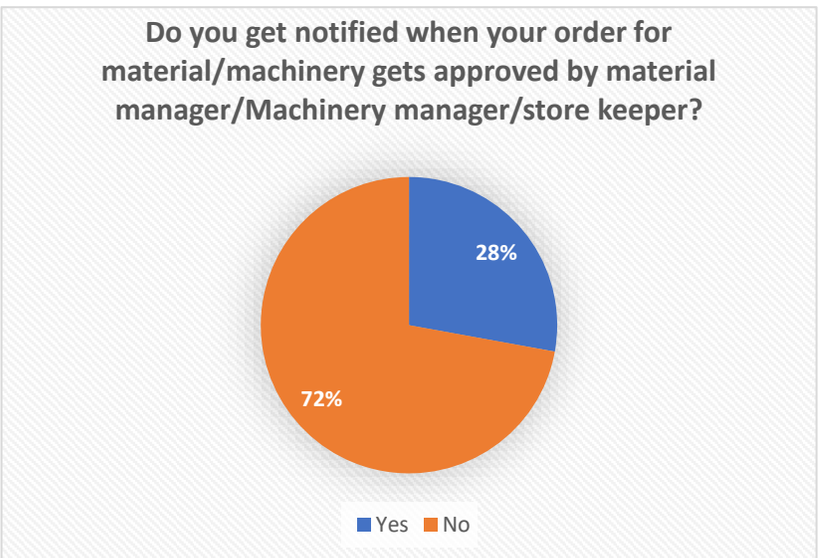
Almost every construction professional agreed to the fact that improper management of material and machinery causes time and cost over-runs.



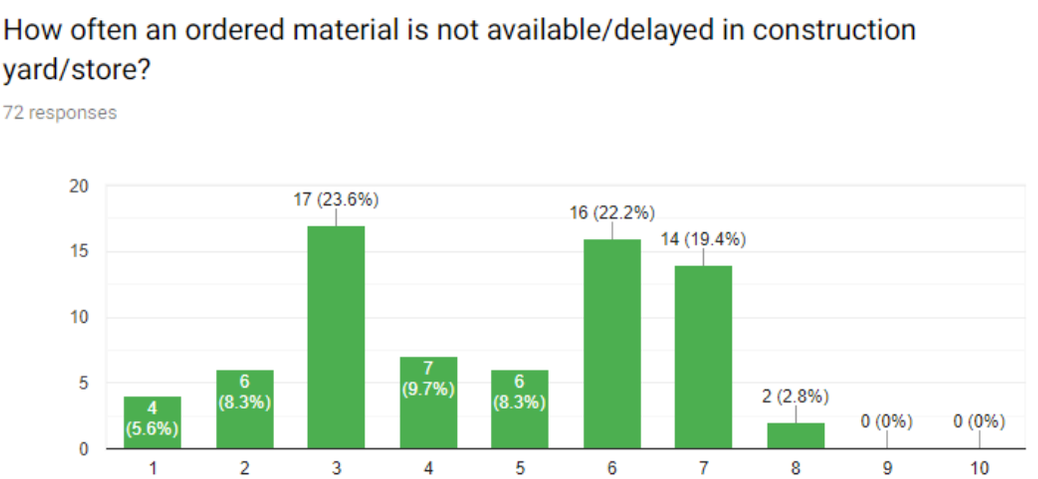

A very mixed response was received to this question but the most selected option was that of more than 20 requests being handled each day but we had a lot of responses telling us that they were handling less than this number. Overall, the weighted average method estimates that average of 20 requests are being generated daily and a lot of paper is being used in this process.



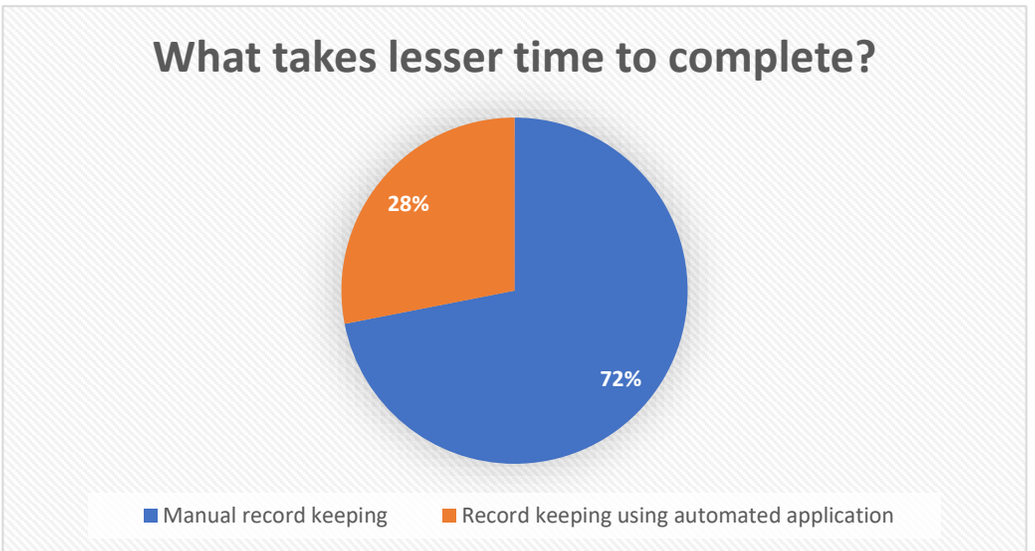
One of the important questions was that whether construction workers were notified about the approval of any of their requests and as expected around 3/4$^{th}$ of the people are not being notified if the request has been approved or causing confusion and sometimes delays.



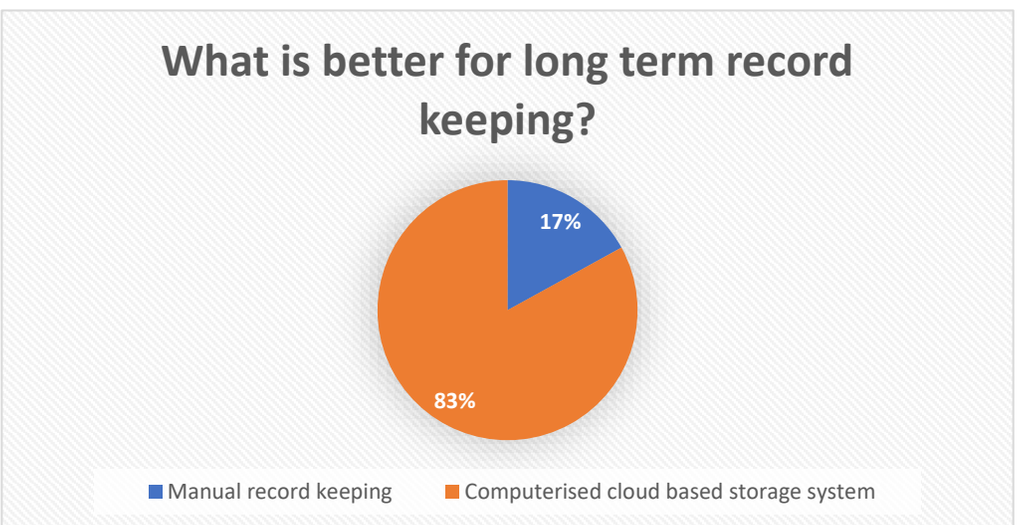

Mixed response to this question was received as well but the results indicated that it happens a lot that materials are not available or are delayed in construction yards.



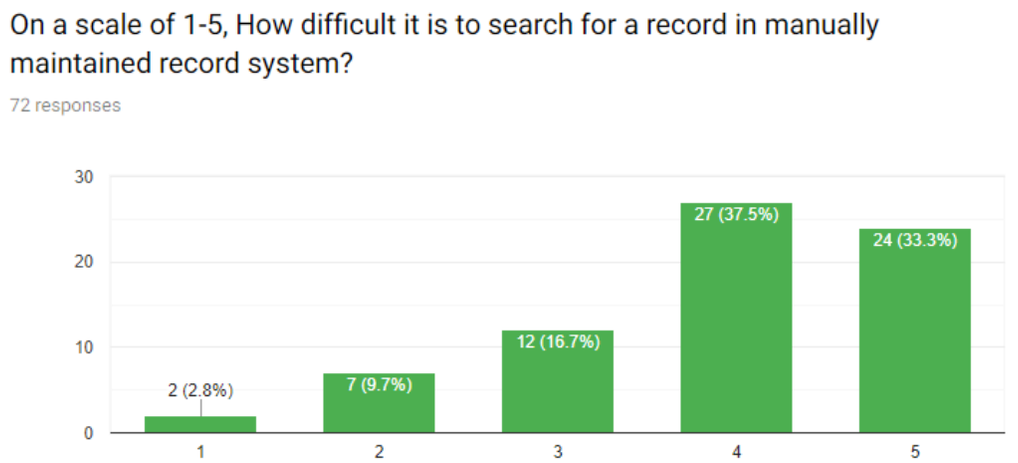
As this is the crux of our project and as expected most of the construction professionals believe that record keeping using an automated app takes lesser time to complete as compared to manual record keeping.



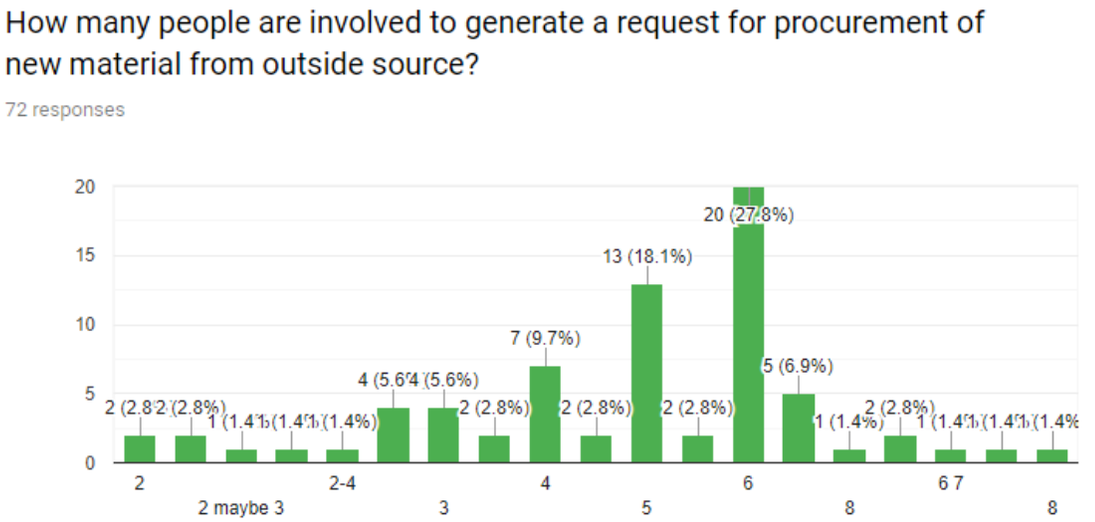

Most of the construction professionals believe that for long term record keeping computerized systems are more reliable as compared to manual record keeping as paper work records are more prone to be lost, damaged or destroyed by water, fire or any other hazard.



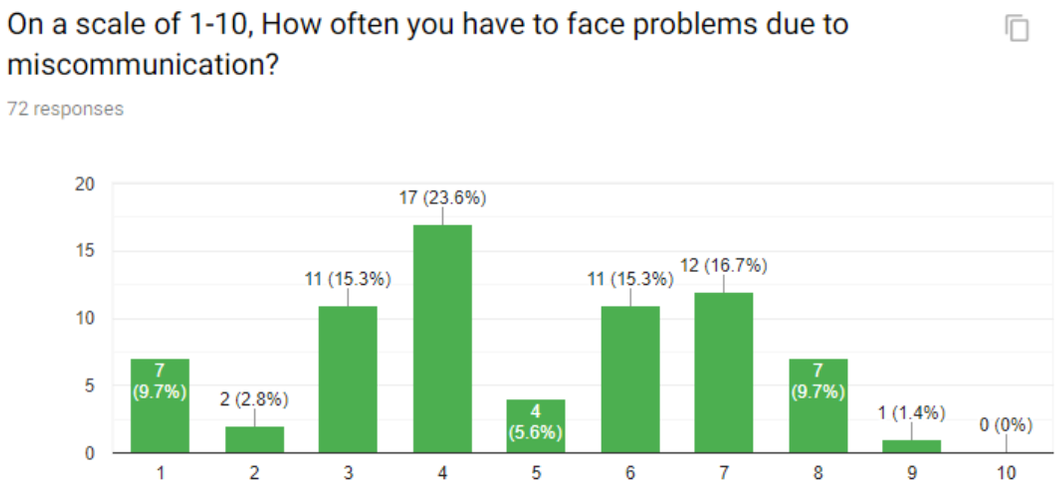
As expected, results obtained from surveys indicate that it is very difficult to look for a record maintained manually as compared to a record on a computer system.



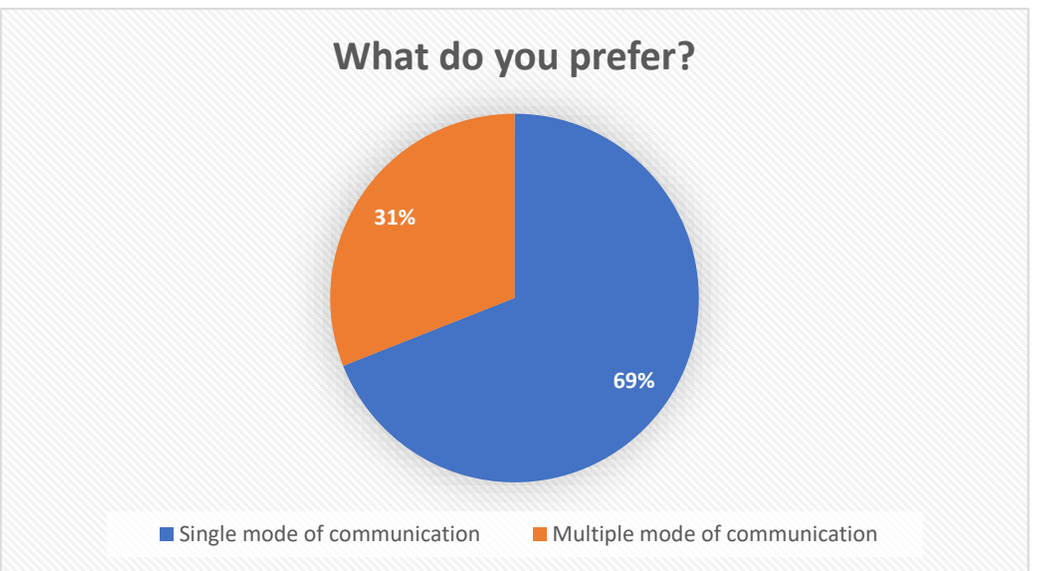

Variable response was received to this question, so weighted average comes out to be 4-5 people involved in procurement cycle.

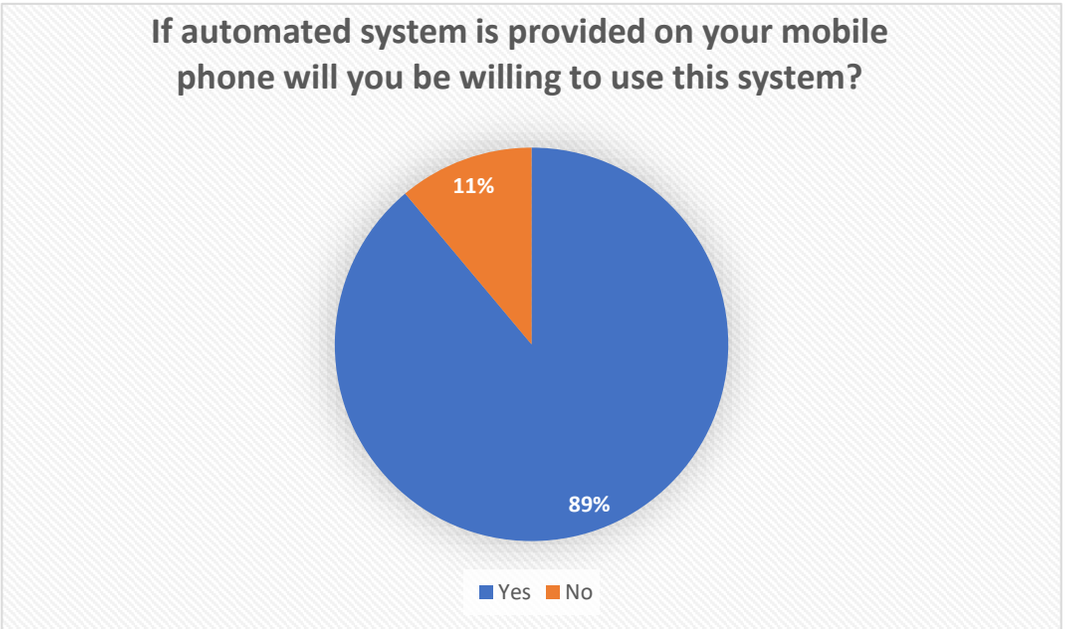


On site miscommunication is common and can cause great problems and this issue can be mitigated by single channel mainstreamed communication.




On site personnel are more inclined towards single modes of communication as compared to multiple modes of communication.






Final and most important question was that whether construction workers would be inclined to use an automated system and to our delight almost 90% people agreed to using an automated giving us a ground to move forward with our project.

## 4.2 APPLICATION INTERFACE

Different screenshots from mobile application are as follows and can be used as a reference that how much accessibility is provided to the app users.

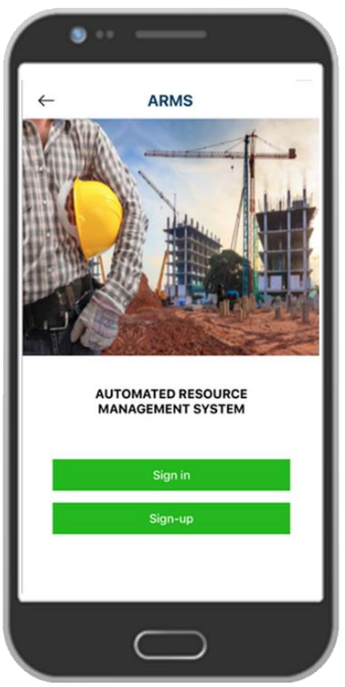



Figure 4.1: Sign-up/Sign-in Screen

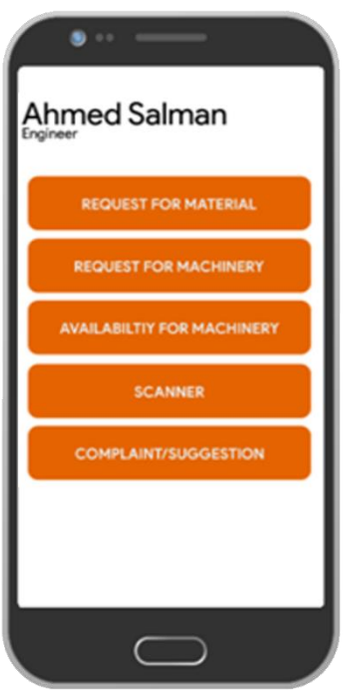



Figure 4.2: Engineer's Screen

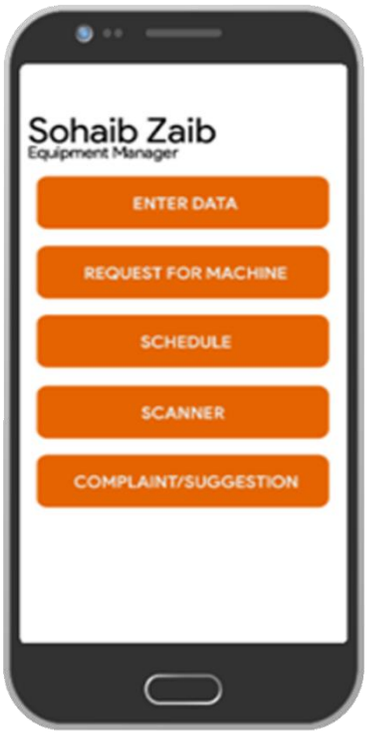



Figure 4.3: Equipment manager's Screen

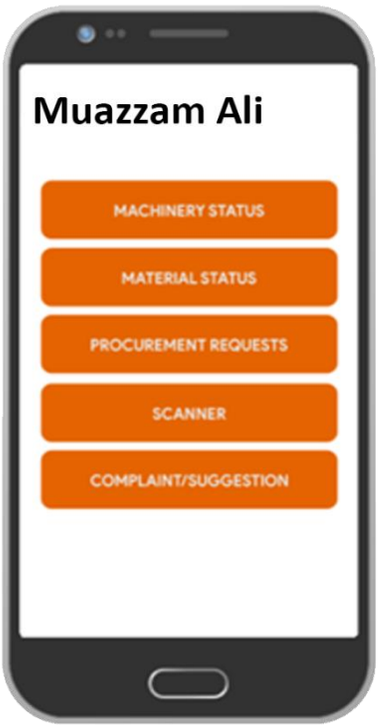



Figure 4.4: Project Manager's Screen

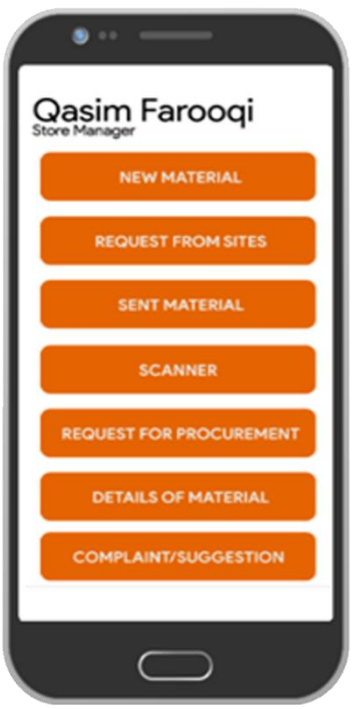



Figure 4.5: Store Manager's Screen

Different screens of mobile based application are attached. These screens clearly show the activity any personnel can perform and the information to which one can access according to hierarchy of organization. When some action is performed by any personnel then the related personnel to that activity gets a notification enforcing the proper information delivery system.

*Chapter 5*

# CONCLUSIONS

## 5.1 CONCLUSION

### 5.1.1 App Development

An App namely “Automated resources management system” was designed using:

- Elaborate field surveys to identify major problems commonly being faced at construction site.
- Design of a proper working plan to automate the on-site management system and to make this process as fast as possible to be implemented on various construction sites in Pakistan. This framework used different automation techniques like QR codes and using mobile applications.
- App Prototype was developed and incorporates a futuristic approach to on-site resource management system providing ease of usage.
- Different on-site personal are given different kind of access to the information providing ease of operation and ease of data keeping.

### 5.1.2 Sustainability

Environment friendly process: On average a single construction professional handles about 15 requests for material daily (according to survey conducted by us) that amounts to around 5500 pieces of paper yearly per person. If the procedure of onsite resource management is automated this results in a great reduction in paper consumption on construction sites.

Similarly, we can save good amount of paper used in different processes of construction sites.

### 5.1.3 Cost Analysis

Implementation cost for this project is mentioned below. As this Application will be used on large scale construction projects so the cost for implementing this system is negligible compared to project cost.

Cost for development of mobile application is Rs. 85,000/-. Also, as the mobile application uses QR tags technology for different processes so there would be need for QR tag printer which costs Rs.5000/- only. QR scanners are mobile based and are built in function of every Android and IOS devise.

## 5.2 RECOMMENDATIONS

Following are some of the recommendations at the end of this project

- A project done by students of batch 2013 completed a project in which they made a website "suppliers.com.pk" connecting clients to material suppliers through that website. We recommend that our app be connected to "suppliers.com.pk" so that outside material procurement be automated as well using this website.

- Using similar technologies and idea, system for automated management of manned resources should be planned.
- App can be linked with primavera schedule to monitor the progress and timely notifications of procurement of materials can be obtained from it.

## 5.3 LIMITATIONS

- In construction sites in Pakistan implementation of such an automated system will cause some problems as most of the labor force is untrained and will have to be trained to use this method.
- Lack of funds to get the app developed.
- Lack of co-operation from field personnel to disclose actual field statistics and information.

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