Developing a Cost-Effective Web-Based Communication and Information Management System for Construction Projects

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Abstract— Construction projects face several problems due to the lack of well-organized communication and information management within construction sites. The traditional communication and information management system in the site is almost run on traditional processes which makes the project delayed, misled and inefficient. Certain IT solutions have been introduced from time to time for the construction industry, and they are costly as well as do not exactly suit Sri Lankan construction conditions. Being a third world developing country, cost-effective solutions that suit the Sri Lankan construction conditions are essential. Therefore, this study aimed to develop a low-cost web-based application to communicate, make decisions, and handle information within a construction site matching the Sri Lankan construction conditions. A web-based application was developed (prototype) according to the collected expert ideas by considering their experience related to the construction sites in Sri Lanka. Semi-structured interviews were adopted to collect the relevant data, and content analysis was used to analyse them. Eventually, considering all of the above, a web-based prototype was developed to manage communication and information within the construction site. Minimizing contradictions within the worksite by providing a virtual platform to communicate with relevant parties, managing information by providing virtual document store in relevant locations, notifying tasks, etc. are provided as functions by the system.

Keywords: *web-based, communication, construction site, information management*

I. INTRODUCTION

The organizational communication simply refers to the exchanging information, ideas, particular knowledge, skill and the technology within the team members and organization in high accuracy (Sherif & Rodney, 2003). The client, designer and the builder are the main three formal communication parties that involve in a construction project (Andrew W. O., 2013). Construction sector is one of the largest industries, consisting of a low innovative rate and its projects have significant challenges as it runs on competitive and complex environment with management difficulties and it should not be ignored or underestimated while providing solutions to overcome these problems (Vasista & Abraham, 2018). One of most important factors of a successful project is the communication among the participants as there are numerous parties that involve in a project (Nipa, Kermanshachi, & Kamalirad, 2019). While many organizations work towards a single construction project (though they are located in different areas), there should be an inter-organizational communication method which is maintained under the guidance of the project manager and it helps all the stakeholders to work towards the same project (Ahuja, Yang, & Shankar, 2006; Sherif & Rodney, 2003).

Information and Communication Technology (ICT) involvement in construction projects plays a major role to improve productivity and quality in different aspects of the industry while providing some useful factors that associated internally with a project such as team management, technology and organization, strategic benefits, employee satisfaction, adapting niche requirements, moving online and

empowering semantics while reducing the issues regarding the project (Ednah & Michael, 2011). Most common problems happen in construction sites related to communication are misused or an open lines communication (protocols) is not used, inappropriate communication channels (inefficient and/or ineffective), and unexpected communication breakdown (Eddie, Heng, Peter, & Zahir, 2001). Therefore, it is essential to use the right source, through the right medium(s) in forms or formats as the receiver can easily comprehend and deliver to the right person (Nathan, Stanley, Fidelis, & Uchenna, 2018). There, the price, importance, quality, location(s) and characteristics of the information are considered when selecting the proper communication media or channels to a certain project (Nuria, Carles, Sonia, & Rafael, 2017).

Although there are some virtual models have been developed to manage the information in construction industry, most of them are very high in cost as well as do not exactly suit for Sri Lankan construction conditions. Therefore,being a third world developing country, still there is a need of a proper, cost effective platform to communicate and manage information within the construction sites in Sri Lanka. Therefore, this research was aimed to design a low cost, efficient and effective web based platform to manage and communicate information within the construction sites in Sri Lanka. Further, this research paper presents the operational aspects of the system as well.

II. LITERATURE REVIEW

A. Communication in Construction Site

In considering the documents which circulate within a construction site, the drawings receive a significant place and they transfer as CAD or any other digital form with DWG, DWF, or PDF extensions (MAGDY, ROBERT, & GEORGE, 2004). Further, the researchers reveal that the main reasons for failures related to traditional drawings and other documentation are high time consumption, misplacing information easily, difficulties in handling, etc. (Nathan, Stanley, Fidelis, &Uchenna, 2018). Electronic documentation (e-documentation) is being used as a solution for the issues that arose with traditional paper-based documentation and it

has a significant impact on construction project management within the last few years (Changxin & Jim, 2012). Information and communication technologies (ICT) in modern day helps to circulate communication within construction sites while changing people interactions and overcome relational problems by reducing the face-to-face contact (Andrew, David, & Michael, 2006).

B. Web Based Management Systems

Websites have become crucial information transferring media for companies and organizations as they manage economic transactions as well as highly important information through websites (Cornelia & Paolo, 2004). Moreover, websites have been developed for the highly secured information transactions for the past few years with some methods to encrypt the messages that do not decode until it reaches its original client (Nighat & Sayed, 2011).

The web based project management is one approach with the ability to strategize, organize and manage streams of resources including resource approximations, structures of resource breakdowns, availability of the resources and resource optimizing in accordance with the complexity of the software (Management, 2008).

There are some strengths that can be seen in the current web based management systems as these projects can minimize the problems due to distance while developing strong and easy collaboration and communication, and minimize the time consumption for the re-working activities (Karatzas, 2010). Nevertheless, there are some weaknesses in web based systems such as technological issues that can provide access to the data with managing issues and make harm to the project management and planning, increase risk in data security, make changes in progress monitoring and quality control (Martinez, Marín, & Vila, 2015).

III. METHODOLOGY AND DESIGN IMPLEMENTATION

Research Appraoch can basically be categorized into three as Quantitative, Qualitative and Mixed (Anuradha, Perera, & Mallawarachchi, August 2018). There, the qualitative approach is adopted to collect the opinions of people / professionals and quantitative approach is used for numerical

and development related works (Anuradha, Perera, & Ekanayake, 2019). Mixed approach is a method that combines both of these (Anuradha, Perera, & Mallawarachchi, August 2018). Thus, this research followed mixed research approach for the analysis. In accordance with the aim of this research, it was intended to develop a web based cost effective virtual communication and information management system for the constructions sites in Sri Lanka. Specially a system such as Enterprises Resource Planning (ERP) is too costly (millinons in SL rupees) to implement for a construction company and not affordable for many of the construction companies in SL. Moreover, they have been developed as it is more suitable for the construction conditions of other countries. Therefore the system was designed as a low cost application mainly focusing the SL construction conditions.

As the first step, it was necessary to collect the ideas of the construction professionals (who are handling the construction documentation and make decisions based on those) to develop the system as it suit for SL construction sites (refer table -1 for the profiles of professionals). Next, collected data were analysed through content analysis. Then the web based model was developed using Windows 10 operating system, Node.js Server and MongoDB as the database. The figure 1 (use case diagram) shows the main functions that can be accessed by the user and admin separately. Furthermore, this model includes a security system that has been designed to restrict unwanted access, a notification system, a quick access contact list and other privileges.

While the back end of the system was designed in accordance with above, the front end of the system was developed as a user friendly interface. The front end of the system includes various pages as eg:- Login page, Home page, User profile, User management, Admin profile, Blocks layout, Task Management etc... and all these are connected internally with the back end. The login page was designed to restrict the unwanted access by providing a password for each user and home page was designed with project details and the block identification.

The admin profile of the system has been designed to manage users (add a new user/ edit user details/ delete a user profile) manage tasks (add tasks/ assign tasks/ edit tasks/ send completed tasks for the approval/ approve completed tasks, etc.) and manage files in a particular block (add documents/ delete documents/ view documents, etc.). The user profile of the system has been developed mainly in viewing to-do tasks, add new task, assign relevant officials, submit completed tasks for approval, give comments, view comments, view documents, access contact list and view notifications, etc.

Table 8: Profiles of the interviewees

Interviewee	Designation	Experience
A	Project Manager	10 years
B	Civil Engineer	08 years
C	Quantity Surveyor	15 years
D	Civil Engineer	07 years
E	Services Engineer	08 years
F	Quantity Surveyor	07 years
G	Senior Site Supervisor	06 years
H	Architect	10 years
I	Quantity Surveyor	08 years
J	Civil Engineer	08 years
K	Senior Site Supervisor	10 years
L	Project Manager	09 years
M	Senior Site Supervisor	14 years
N	Architect	06 years
O	Services Engineer	08 years
P	Senior Site Supervisor	07 years
Q	Civil Engineer	06 years
R	Services Engineer	11 years
S	Quantity Surveyor	08 years
T	Services Engineer	08 years
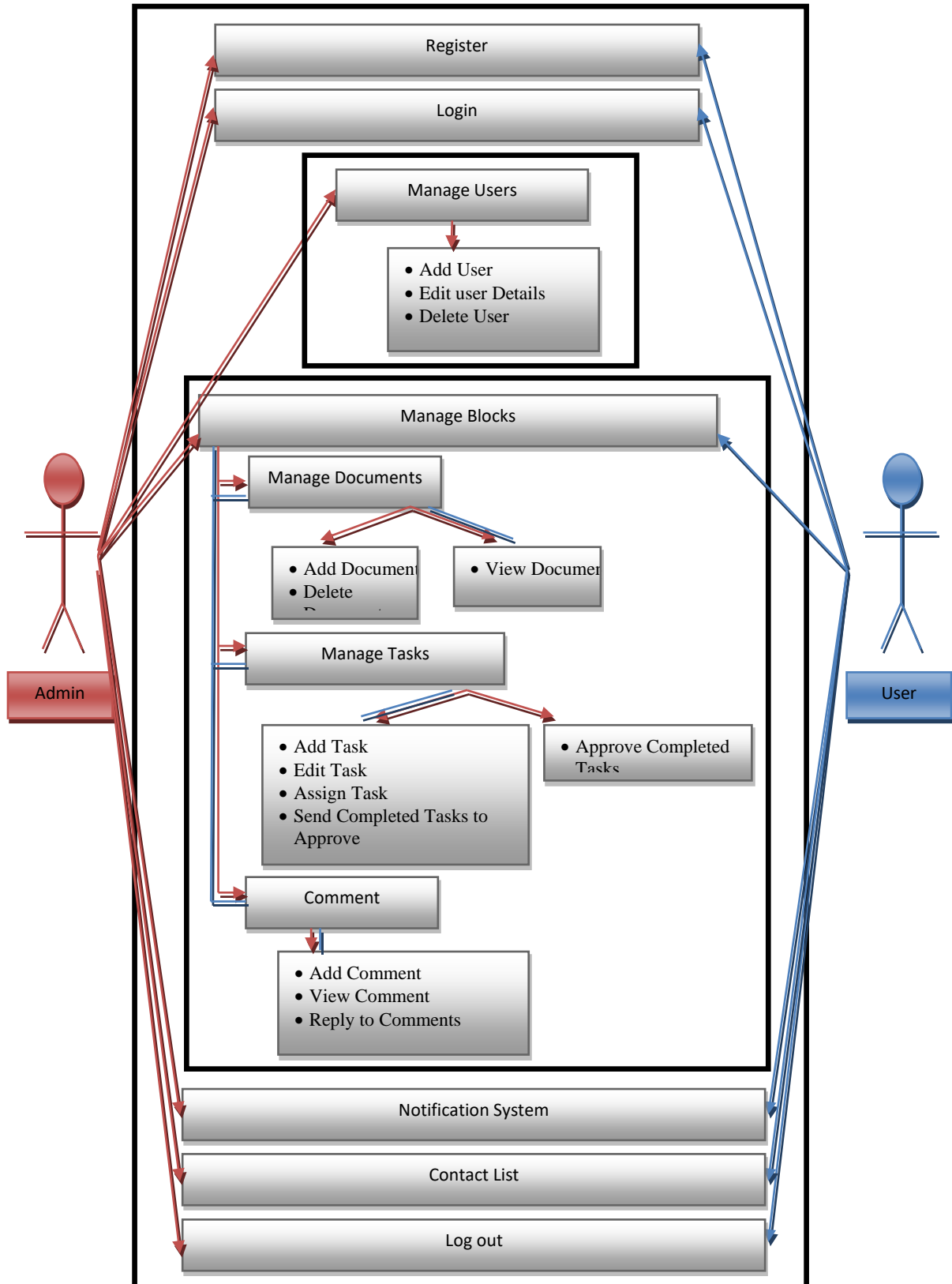
Users receive a notification when new comment added, a document added or when they have
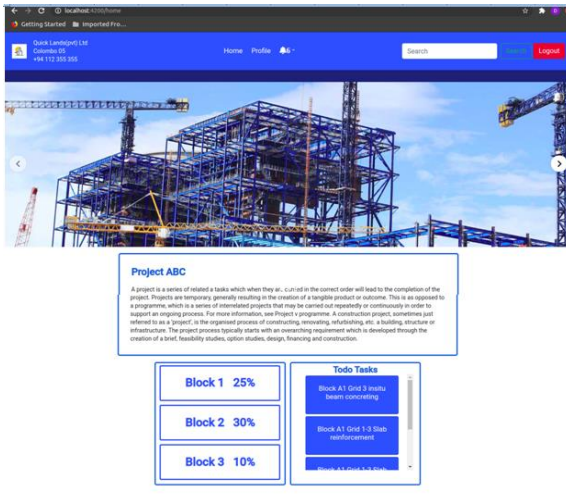

Figure 21: Home Page

been assigned to a new task in the system irrespective of the block or the place they work. This is a bonanza to manage communication within large scale construction sites easily. Then the particular block within the developed website has been designed including relevant document section with document categorization,
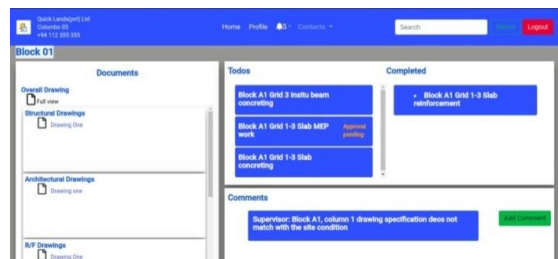

Figure 22: Block Layout

view tasks (to-do), completed tasks and providing a comment section. Further, the tool bar within the home page provides quick access to the contact details of each member in the site and admin has the full authority to make changes to the details and he is responsible about unnecessary changes in contact details. This contact list provides the mobile phone number and official mail addresses of each official. These facilities of the system help to communicate and manage the information in many ways, such as new documents (e.g: updated site instructions, RFIN (Request for Information), method statements) are accessable in any place of the work site. If any issue arise at any location of the

construction site, the user can insert a comment to the system (in the relevant block) by
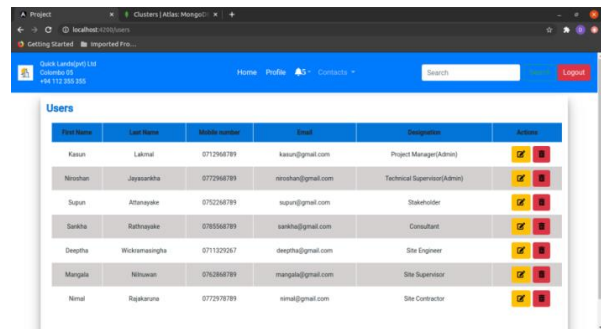

Figure 20: User Management

mentioning relevant officials to get quick solutions. The officers receive reminders at the beginning of the particular task so they can
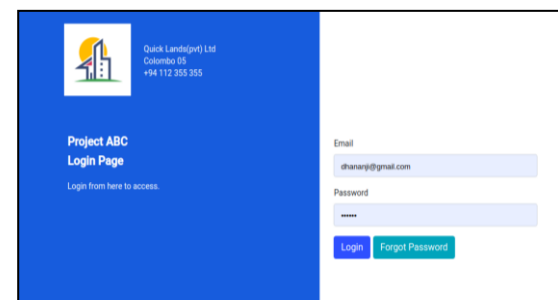

Figure 24: Login Page

access the places easily. This function is really helpful for the relevant Mechanical, Electrical and Plumbing (MEP) professionals as they do not stay in a particular single block.

Figure 23: Tasks Management

Moreover, this system helps to reduce the wastage of time by providing the relevant details and information in quick time, reminding the to-do tasks, inquiring the issues in the comment section and get solutions and feedback without

any further delay and access the contact details of the officials easily.

IV. CONCLUSION

This study was basically focused on developing a cost effective web based system for the construction sites in Sri Lanka as a solution for the communication and information management. This model can manage tasks within the site, manage users, manage documents and provide a common discussion section in the comment area and targets the primary requirements of the site which is basically subjected to the day to day activities of a construction site.There are certain benefits of adopting this web based application rather than using any other system or the conventional manual communication management process. First and foremost thing is this is really economical and saves a significant amount of money. Further, time saving, having the accessibility for the users with different devices (smartphones/ tablets/ personal computers/ laptops) and differenet locations, easy customization in different devices, easy integration with various operating systems (windows/ android/ Ios/ mac os), and maintenance requirement, adoptability, etc. can be highlighted as other advantages. Moreover, this system can be considered as a formal communication platform as it has only the authorized documents and officials are responsible for their behavior in the system. Therefore, no one can insert irrelevant information to the system. It leads for high efficiency in communication to deliver accurate and quality information on time.

This system has a limitation as all the responsibilities are handled by the admin. If this system can be upgraded with artificial intelligence, most of the works of admin can be converted to a self controller by the system.

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