

**ASSESSMENT OF ELECTRONIC DOCUMENT AND
COMMUNICATION MANAGEMENT SYSTEMS IN
CONSTRUCTION PROJECTS**

**MASTER OF SCIENCE
IN
CONSTRUCTION PROJECT MANAGEMENT**

Kudaligamage Eshan Saminda Perera
(158978M)

Department of Civil Engineering

University of Moratuwa

July 2019

**ASSESSMENT OF ELECTRONIC DOCUMENT AND
COMMUNICATION MANAGEMENT SYSTEMS IN
CONSTRUCTION PROJECTS**

BY

**Kudaligamage Eshan Saminda Perera
(158978M)**

Supervised by

Dr. C.S.A Siriwardana

“This dissertation was submitted to the Department of Civil Engineering of the University of Moratuwa in partial fulfilment of the requirements for the Master of Science in Construction Project Management”

Department of Civil Engineering

University of Moratuwa

July 2019

Declaration

I certify that this thesis does not incorporate without acknowledgement any material previously submitted for a Degree or Diploma in any University to the best my knowledge and believe it does not contain any material previously published, written or orally communicated by another person or myself except where due reference is made in the text.

I also hereby give consent for my dissertation, if accepted, to be made available for photocopying and for inter library loans, and for the title and summary to be available to outside organizations.

.....

Signature of Candidate

K.E.S. Perera
158978M

.....

Date

The above particulars are correct, to the best of my knowledge.

.....

Signature of Supervisor

Dr. C.S.A Siriwardana
Department of Civil Engineering
Faculty of Engineering
University of Moratuwa

.....

Date

Dedication

I would like to dedicate

This thesis,

To my Parents and Wife,

Whose affection, love, encouragement, and prayers

of day & night make me able to

Get such success and honour,

And teachers, who taught me

To think, understand and express.

I earnestly feel that without

their inspiration, guidance and dedication

I would not be able

To pass through the tiring process of this research.

Acknowledgement

It is a great pleasure to offer my sincere gratitude to all individuals who contributed and helped me in various ways to make this research a success. Firstly, I would like to express my sincere thanks to Dr. Chandana Siriwardana, Senior lecturer, Department of Civil Engineering, Faculty of Engineering, University of Moratuwa, the research supervisor of this study, for assisting and guiding me towards the right direction to achieve this goal.

I am grateful to Central Engineering Consultancy Bureau, my current employer, for the great professional exposure provided for their employees which was a enormous support for me to carry out this research and further, for facilitating my course attendance.

I express my gratitude to my colleagues, friends and many others, who supported me whole heartedly in this career. Last but not least, I am greatly beholden to my parents and wife for their endless patience, encouragement and support given throughout the study.

Abstract

Effective communication plays a major role in a project towards its success. Today, most of the construction projects deal with stakeholders around the world. Therefore, it is essential to have a proper communication channel for the smooth flow of the project execution. Traditional paper-based communication seems to be not practical in this context and the requirement of an alternative method is essential. In this regard web-based electronic document and communication management system can be proposed as a solution. In the construction industry, documents and drawings related to various disciplines such as engineering, architectural, planning, financial etc. are widely used. Electronic document and communication management systems can handle both incoming and outgoing correspondence related to a project in one place with a defined access. Nowadays, internet and other communication means are booming up and construction industry too has a tendency of moving to the electronic documentation and communication management systems. Since, it is a new transformation in the construction industry, most of the stakeholders are still in a dilemma on upgrading their existing systems. This research assesses the potential reasons, whether to adopt or avoid the electronic document and communication management systems for construction projects and further the benefits and challenges of implementation of such systems in a project by conducting the industry survey and the case study.

TABLE OF CONTENT

1. INTRODUCTION	1
1.1 Background	1
1.2 Problem Statement	3
1.3 Objectives	3
1.4 Research Methodology	4
1.5 Limitations of the Study.....	6
1.6 Research Deliverables.....	6
1.7 Guide to Thesis	6
2. LITERATURE REVIEW	8
2.1 Document Management System	8
2.2 Evolution of Document Management in Construction Projects	8
2.3 Web based Document Management System.....	9
2.4 Requirement of an EDMS.....	10
2.5 Benefits of the Implementation.....	11
2.6 Features of EDMS.....	12
2.7 Challenges of the Implementation	13
3. RESEARCH METHODOLOGY.....	14
3.1 Method of Data Collection.....	14
3.2 Questionnaire Content	14
3.3 Pilot Study.....	15
3.4 Method of Data Analysis	16
4. DATA COLLECTION AND ANALYSIS	17
4.1 Respondents Background.....	17
4.2 Existing Communication System and Previous Experience.....	19
4.3 System Security & Reliability	20
4.4 Legal Acceptance.....	21
4.5 Facilities Required	22
4.6 Coordination Issues.....	22
4.7 Search of Past Documents	23
4.8 Storage Mode	24

4.9 Challenges of Implementation of EDCM System	25
5. CASE STUDIES OF COMMUNICATION AND DOCUMENT MANAGEMENT SYSTEMS.....	28
5.1 Project A	29
5.1.1 Project Description.....	29
5.1.2 Stakeholders of the Project	29
5.1.3. Current Document and Communication Management System.....	29
5.1.4. Volume of Documents Transferred.	30
5.1.5. Observations on Current system	32
5.2. Project B.....	35
5.2.1. Project Description.....	35
5.2.2 Stakeholders of the Project	35
5.2.3. Current Communication and Document management system	35
5.2.4. Reasons for the Adoption of Letter management system.	36
5.2.5. Volume of Documents Transferred.	36
5.2.6. Observations on Current System	37
5.3 Project C.....	40
5.3.1. Project Description.....	40
5.3.2. Stakeholders of the Project	40
5.3.3. Current Communication and Document Management System	41
5.3.4. Reasons for the Adoption of Web based EDCM System	41
5.3.4. Volume of Documents Transferred.	42
5.3.5. Observations on Current System	42
5.4. Summary of Case Studies	46
6. CONCLUSIONS AND RECOMMENDATIONS	49
6.1 Conclusion	49
6.2 Recommendations.....	52
REFERENCES	54
APPENDICES	57

LIST OF FIGURES

Figure 1 Research Methodology.....	5
Figure 2 Questionnaire Format.....	15
Figure 3 Type of Project.....	17
Figure 4 Type of Client.....	18
Figure 5 Type of Participant.....	18
Figure 6 Prime Communication Mode of Project.....	19
Figure 7 Previous experiences on ECDM.....	19
Figure 8 Security Issues.....	20
Figure 9 Legal Acceptance.....	21
Figure 10 Facilities Required.....	22
Figure 11 Coordination Issues.....	23
Figure 12 Searching Facility.....	24
Figure 13 Storage Mode.....	25
Figure 14 Challenges of implementation EDCM system.....	26
Figure 15 Comparison between Government and Private sector.....	27
Figure 16 Letter Log – Project A.....	30
Figure 17 Process of Document approval in Project A.....	33
Figure 18 Letter Catalogue - Project B.....	36
Figure 19 Photo Catalogue - Project B.....	38
Figure 20 Drawing Register - Project B.....	38
Figure 21 User Interface in Aconex.....	43
Figure 22 Process of Document approval in Project C.....	44

LIST OF TABLES

Table 1 Scale used for data measurement.....	16
Table 2 Stakeholders Background and Project Details.....	28
Table 3 Volume of documents transferred in Project A	31
Table 4 Volume of documents transferred in Project B	37
Table 5 Volume of documents transferred in Project C	42
Table 6 Summary of Project details.....	46
Table 7 Summary of advantages and disadvantages on document management system	47

LIST OF ABBREVIATIONS

Abbreviation	Description
AGM	Additional General Manger
BIM	Building Information Modeling
BOQ	Bill of Quantity
CIDA	Construction Industry Development Authority
DMS	Document Management Systems
EDMS	Electronic Document Management Systems
EDCM	Electronic Documents and Communication Management
ELV	Extra low voltage
IPC	Interim Payment Certificate
IT	Information Technology
LAN	Local Area Network
LP	Liquefied Petroleum
MEP	Mechanical Electrical Plumbing
MCM	Million Cubic Meters
NSC	Nominated Sub Contractor
PA	Public Address System
PDF	Portable Document Format
PM	Project Manager
PMD	Project Management Division
RE	Resident Engineer
RFI	Request for Information
RII	Relative importance index

LIST OF APPENDICES

Appendix	Description	Page
Appendix - A	Sample Questionnaire	57

1. INTRODUCTION

1.1 Background

Communication and document management systems play a key role in project management component of a construction project. Proper communication and documentation are important factors for the smooth flow of a construction project. When proper methodology is not communicated properly to the ground level workers on site, it will affect the quality of the construction activities resulting cost, time and scope differences. Most of the cost variation originated in the construction projects can be identified as a result of the poor communication and poor coordination among different groups involved in the project at design level as well as the construction stage. Lantham (Latham, 1994) also explains that a poor project organization, a lack of attention to detail relating to project structure, communication, and execution can be singled out as a key factor in many cost over-run projects. Construction site safety also a critical issue that can be affected when decision taken by the project management level is not properly conveyed to the workers at site level.

There are several stakeholders involved in a construction project management, such as Client, Engineer, Consultant, Main Contractor, Subcontractors, and Quantity Surveyors, etc. They might be located around the world. The project becomes more and more complex, when the number of parties involved are high. In this background, traditional methods of printing and delivering hard copies and email exchanges do not work (Björk, 2002). Alternative method is much needed to handle this situation and it becomes a requirement to adapt a communication and document management system that will offer much convenient and effective communication and document control for the entire project team.

Nowadays, information technological applications, the internet and other communication means are booming. The Internet is changing the way business is done in construction. Despite the immaturity of the technology and its short history, e-business initiatives are already transforming industries and becoming a key component. Construction industry too has a tendency of moving to the Electronic Documentation and Communication Management (EDCM) systems.

A fully functional web based EDCM system is a good solution for issues prevailing in construction industry and it provided numerous facilities such as document management,

project controls, workflow management, RFIs, mail & forms, BIM management, quality & safety management, bidding & tenders, contract management and report generating. Apart from that online discussion provides a quick solution for the coordination issues arises in both design and construction stages which helps to overcome the unnecessary project delays. In addition, advance searching facility can be used to track past project documents within a very short period of time. (Nitithamyong & Skibniewski, 2004).

However, (Egan, 1998) further recommended that technology on its own cannot provide the answer to the need of greater efficiency and quality in construction. There were considerable examples of new technology being used to reinforce outdated and wasteful processes and it does not work at all. The advice offered to construction by leading manufacturing industries is to approach change by first sorting out the cultural background, then defining and improving processes and finally applying technology as a tool to support these cultural and process improvements (Egan, 1998).

There are various barriers for the implementation of a new system such as technical, behavioral, cost-related and legal. Therefore, most of the companies are still in a hesitation to adopt a new system over the existing traditional paper-based communication system due to various reasons (Wong, 2012). Most of the time, prime reason may be unawareness about these systems and functions of them by traditional method followers.

This research assesses current awareness level of communication and documents management system in construction industry and its benefits and challenges of the implementation of such systems in a construction project. Further, this study compares the advantages and disadvantages of the electronic and traditional paper base communication. Finally, this research assesses the potential reasons, whether to adopt or avoid the EDCM systems for construction projects.

1.2 Problem Statement

In most of the construction projects and firms use traditional paper document communication and Management systems which is getting out dated in the context of modern diversification of project structures. Furthermore, in most congested cities, it is not practical to have all the stakeholders together to work under one roof and different disciplines located in different locations of work to achieve one common goal. In this scenario EDCM system provides a great platform to improve the efficiency the work flow. Most of the construction projects still not adopted to such system for communication and documents management and this may be due to various reasons.

Nowadays Information Technology (IT) field standing up and construction industry also has a trend on moving to EDCM systems instead of traditional documentation. Some of the clients and project managers already taken initial steps to implement new systems for their projects. Since it is a new transformation for construction, most of the stakeholders are still in an uncertainty on changing their existing systems.

In this research, it assesses the potential reasons to adopt or avoid the EDCM Systems for construction projects and the pros and cons encountered after the implementation of such systems for projects.

1.3 Objectives

The main objectives of this research as follows,

- To investigation of existing the document and communication management systems in construction projects (Government & Private sector).
- To investigation the reasons behind adoption of the prevailing document and communication management Systems.
- To assessing the benefits and challenges of implementation the electronic document and communication management systems.

1.4 Research Methodology

The requirement of a research on Communication and Documents Management systems was identified due to the difficulties experience in construction industry. Firstly, research scope and objectives were defined as per the findings of a desk study carried out. Then a detail literature survey was carried out to gain an idea about past researches and to identify the research gap. Based on the findings of literature survey, questionnaire preparation was done to gather data about existing Communication and Documents Management systems that are currently practising in the construction industry. Modification to the questioner was done based on the comments received by the pilot survey which was carried out among few individuals.

Then main survey was carried out by circulating the questionnaire among the stockholders in construction industry and the data obtained from the survey was analysed using a statistical method. Simultaneously, case studies about Communication and Documents Management systems on three construction projects were conducted to verify the results of the questionnaire survey. Finally, recommendations and a conclusion were stated based on the findings of both questionnaire survey and case studies. The summarized research methodology is illustrated in Figure 1.

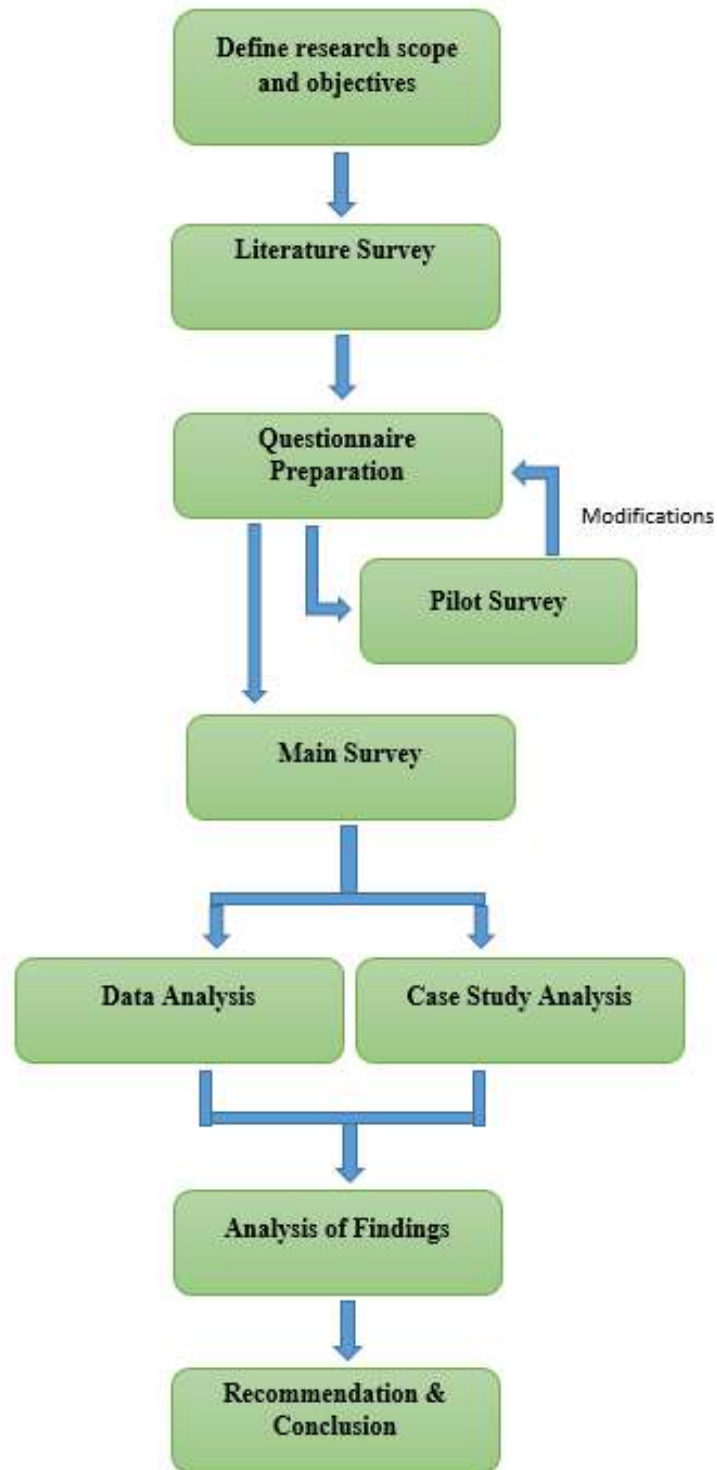


Figure 1 Research Methodology

1.5 Limitations of the Study

There are two major limitations in this study that could be addressed in future researches. Firstly, this research highly depends on the growth of Information Technology (IT) in a particular geographical area. This study focused mainly on views from participants in Sri Lankan construction industry. Hence, the result of this research basically reflects the local construction industry and modification need to be adopted if the result transfers for the international context.

Secondly, initial questionnaire survey preparation was carried out based on the literature survey due the lack of best matching previous researches carried out for local construction industry.

In addition, the research output is more applicable to building construction projects as 71% of the responses received for the questionnaire were from building sector.

1.6 Research Deliverables

- Identification of document and communication management systems in construction projects (Government & Private sector)
- Identification reasons behind the adoption of the EDCM Systems.
- Recognize the benefits and challenges of implementation of the EDCM Systems.

1.7 Guide to Thesis

Chapter 01 – Introduction

The Introduction offers a brief outline of the research background, problem identification and objectives, limitation of the study and guide to the succeeding chapters.

Chapter 02 – Literature Survey

Chapter 2 discusses the details collected from available literature related to documents management and communication system in construction industry and evaluation of these systems over the period of time. Further in this chapter discusses about benefits and challenges of implementation new system over traditional system and features of web based EDCM system.

Chapter 03 – Research Methodology

Chapter 3 describes the research methodology adopted for this study. Data were collected through questionnaire surveys and format of a questionnaire and details of pilot survey is described in this chapter. In addition, method of data analysis is illustrated in this chapter.

Chapter 04 – Data Collection and Analysis

Chapter 4 illustrates the data collected through the questionnaire survey related to existing Document Management Systems in Construction projects. Further, this chapter describes the detailed analysis of data under different categories and presents the key benefits and challenges of implementation of EDCM Systems.

Chapter 05 – Case studies of document management system

Chapter 05 present the two case studies which practice traditional document and communication method and EDCM system and reasons to adopt particular system with advantages and disadvantages.

Chapter 06 – Conclusions and Recommendations

Chapter 6 has two main sections. The first section describes the recommendation on EDCM system adoption for construction projects, and Second section describes the conclusion of the research.

2. LITERATURE REVIEW

2.1 Document Management System

As per the Oxford Dictionary the word, 'document' means a piece of written, printed, or electronic matter that provides information or evidence or that serves as an official record. Traditionally document is a piece of a collection of papers. During past few years with the development of information technology, the term 'document' has undergone drastic changes. Today documents are considered as computer files stored in individual computers and database servers. (Björk, 2001)

Documents are processed and stored in electronic form is called 'electronic documents' as well as 'E documents'. Information technology is now capable of producing an electronic document which includes text, graphics, audio and video.(Roper & Millar, 1999)

As per the (Bo-Christer, 2001) "An electronic document is an information container in electronic form, which gathers together information from a variety of sources, in a number of formats, around a specific topic to meet the needs of a particular individual"

A user can create an electronic document on a personal computer without creating a paper document. The most sophisticated method currently applied is to use Document Management Systems (DMS), where the documents are stored centrally on a server and users interact with this central repository through interfaces implemented using standard web browsers.

2.2 Evolution of Document Management in Construction Projects

Documents in the construction sector have undergone major changes since the middle of the 20th century. The technology for producing, managing, duplicating, and distributing documents relate to drawings, bills, specification, etc. have under gone many fundamental changes (Bo-Christer, 2001).

Firstly, the introduction of photocopying in the 60's reduced the cost of duplicating information. Afterwards, the introduction of technological innovation such as personal

computing for the day to-day work during the 80's, and the mass utilization of CAD-systems, word -processing and other software, helped to document management.

In the 80's the fax became also a popular data transfer method and was used to handle offers, send graphics, etc., but was not useful for larger drawings or documents.

Finally, in the late 80's and early 90's Internet made possible the document transfer via mail which was a great step for document management.

Nevertheless, on most sites the receipt, creation, authorization and distribution of incoming, outgoing and internal documents, are handled by a manual system totally dependent on the photocopier.

2.3 Web based Document Management System

Currently, it's nearly 10 years after the beginning of the mass commercialization of Internet, the media that have progressed in an exponential way. In its original form, the Internet was used to show information and to send it via mail.

Later, companies felt the necessity to offer services and improve their contents. The most sophisticated method currently applied is the EDMS, where Documents are stored centrally on a web server and users interact with this central repository through interfaces implemented using standard web browsers (Björk, 2002).

The development of network technology has nowadays reached a level where companies, for a relatively low cost, can implement intranet, extranet or internet. This development has evidently been taken up. This condition has led to an increasing number of building projects using a project web as a tool to enable and increase the efficiency of the exchange of digital data between the companies in a building project.

BIM 360 construction management software is one of the key examples for the web-based communication management system which enables anytime, anywhere access to project data throughout the building construction lifecycle. This is a cloud-based planning and collaboration product that connects the entire project team together and accelerates project reviews and empowers multidisciplinary teams to quickly identify and resolve coordination issues.

2.4 Requirement of an EDMS

Electronic Document Management Systems (EDMS) are the innovation which most clearly has passed through the stages in the implementation process. All the information created in project has traditionally been formalized in documents. Drawings, method statements, documents related to contract administration, budgeting, and any other text documents earlier sent in physical form (paper) to participants in project who at any given moment have needed access to the information. For these documents new technology has created possibilities both to easily create via word processing and multiply by photocopying and communicated via email using internet. This has resulted in a strongly increase flow of documents and also other information (Samuelson & Bjork, 2010).

Construction documents have not undergone major changes since the middle of the 20th century. Plan drawings, sections and elevations, bills of quantities, specifications etc. look much the same as decades earlier. The technology for producing, managing, duplicating and distributing such documents has, however, undergone a number of fundamental changes (Hjelt & Björk, 2006).

As per the project-management.com website Construction industry is expected to see a massive growth by the year of 2020. With the construction industry booming, the requirements of skilled professionals will increase and with that relying on document management software (DMS) for their works is expected to grow steadily. Construction DMS is an integrated tool that provides secure and centralized document management system. It offers real time collaboration of the team members and generates reports. Assigning tasks to adding mark-ups in construction documents is easy. The construction project document software maximizes resource efficiency and develops communication (Astor, 2017).

Document management is not a trivial thing. Contracts, compliance documentation, drawings and specs and more all ensure a project is carried out according to plan. These documents play a fundamental role in construction. But many common challenges arise related to document management, even in modern construction organizations. As revisions occur, multiple versions of documents are created, which concerned parties may not be aware of or have immediate access to. This can easily lead to errors and rework if crews consult an outdated document. Further it is difficult to edit or comment on traditional paper-based documents, especially for people who work outside the office (Holtmann, 2018).

2.5 Benefits of the Implementation

The need for increasing the efficiency of the communication processes via exchanging massive volumes of information at high speed and relatively at a low cost has been long recognized by the industry. One of the primary reasons for implementation of web-based systems in most projects is enhance communication between the project participants above and beyond traditional paper-based poor communication which is believed to impact projects significantly by causing delays and inefficiencies (Hjelt & Björk, 2006).

The real benefits start to become visible when certain core application is moved away from individual PCs and run on the server such as an EDMS (Matheu, 2005). Although working in individual PCs may help to process documents for some extent, it will not provide all the facilities which EDMS provide and further it will lead to duplicate softcopy storage. The implementation of web-based Project Management (PM) systems generally help to achieve better communication practices, speed of construction and greater collaboration amongst the project team members (Alshawi & Ingirige, 2003). The efficiencies might not be as easy to be realized by the industry at the early stage of adoption. Technical problems or the cost of using systems are no longer barriers to wide-spread adoption. The importance of using such a system on projects should be realized right at the conception level and necessary precautions are to be taken to ensure the project and the project team members will be benefited to the maximum (Devanand, 2015).

Electronic document management systems do away with the time-consuming process of sifting through paper files at the risk of discovering the document was not properly put away by the last person to pull it. EDM systems allow files to be recalled at the click of a mouse, while providing information on when and by whom the file was last viewed and/or marked up. Documents can be scanned and stored to create an electronic database accessible to users across an enterprise. Cloud-based EDM systems can also allow out-of-office users to Access Company and project-related documents through a wireless connection. Document management systems can be useful for every department within a construction company. The accounting office can better track revenue and expenses by being able to pair order forms with resulting bills from suppliers and store receipts, and project managers can share updated blueprints instantly with on-site supervisors. EDM systems also help companies make sure confidential information is protected, and can ensure compliance with legal regulations,

according to PaperGear.com. Additionally, because files are computer based, electronically backing up files can help reduce the risk of losing important documents in the event of a fire or natural disaster (Sage, 2012).

2.6 Features of EDMS

As per the BuilderStorm well-known software developer the requirements of Document Management Software in construction industry can be quite different from other industries and this dedicated software's shall have four major qualities. They are scalability, compatibility, BIM support, accessibility and management. A most typical characteristic of documents in the construction industry is variation in size. There can be a simple file that can be transferred through email as an attachment or another that is so large that even file sharing services such as DropBox are unable to support it without a hefty payment. Hence, scalability is a major requirement for construction document management software programs. Construction documents are stored on different platforms. This means that a wide variety of designing and management software programs are used to create construction documents. Online construction document management software programs need to be able to support files and documents of all types, regardless of their extensions. The United Kingdom's construction industry is well aware of the government mandate to all construction firms currently handling publicly funded projects. The mandate is simply that documents related to all publicly funded projects will need to conform to Building Information Modelling (BIM) principles by the year 2016. Accessibility is becoming increasingly important within the construction industry. Documents will need to be viewed, edited, and upended by a wide variety of experts and professionals within and without a construction firm. Because so many people will be accessing these construction documents, it's obvious that they will be using a wide variety of devices from a wide variety of locations to gain that access. Thus, accessibility can be said to be closely tied to compatibility as well and, hence, extremely important in document management software for the construction industry. Handling vast amounts of documents even in digital formats can be problematic especially if you have to muddle through an array of types and platforms. In no industry is this aspect of documentation more complicated than in the construction industry simply on the basis of the amount and variety of documents used (Builderstorm, 2016).

As per the Doccept EDMS software provider they are providing multi benefits to end user. Web enabled provide accessed from anywhere in the world through the internet. The documents can be thus managed by anyone from anywhere. Scanner integration enables to scan any drawings or documents and integrate it with the rest of the documents. A pre-defined folder structure enables to shift documents automatically into the appropriate folder or sub-folder, enabling easy retrieval of the documents. Further, employees can view AutoCAD documents (drawings) from anywhere without having to install the expensive software if they are accessing random systems while on-site. Employees can upload documents from anywhere and all versions of the documents are saved and maintained for record keeping. It is possible to view who has created, accessed, or modified the documents at any given time. As any other provider this software send specific notifications to specific employees or group of employees and also set alerts for critical dates and tasks. Further it ensures the documents are safe from unauthorized access and deletion (Doccept, 2016).

2.7 Challenges of the Implementation

The lack of training resulted in a higher barrier for adoption, especially among users with limited computer skills and, consequently, sub optimal utilization of the technology available (Mathias & Björk, 2007)[6]. The problem with a system is that successful use requires that all users to adopt the system at the same time (O'Brien, 2000). Usage of technology from third party service is major concern of many stakeholders (Bo-Christer B. , 2003).

One of the barriers that may stop construction companies from adopting electronic systems is that implementing and applying these systems may need a major investment of time, effort and money, while benefits may need time to be noticed. Another barrier is that employees may be unwilling to learn the new methods and procedures of applying a new system. This can be mitigated by applying user-friendly systems. Applying effective electronic DMS can help to improve the learning process of the organization (Ahmad, Bazlamit, & Ayoush, 2017)

3. RESEARCH METHODOLOGY

3.1 Method of Data Collection

A questionnaire survey was carried out to identify the current document management systems adopted in the construction industry and to gather data on the communication methods practiced in construction projects. The questionnaire was distributed online, and hardcopy versions among different disciplines. Each respondent was sent an online version of a questionnaire via an email containing a brief description of the study and personalized link to a web site hosting the actual questionnaire. The questionnaire was distributed to 105 construction professionals, out of which satisfactory 58 responses were received from both modes thus the response rate of 52% was achieved.

Further, case studies of two construction projects were carried out by gathering data by face to face interview on key participants of that project who represent different disciplines and different roles.

3.2 Questionnaire Content

The questionnaire arrangement can be divided into several segments. General information like designation and total years of service in the area of construction industry of respondents were obtained. Secondly, the over-all information of the current project like role of respondent's organization in the project, value of the project, planned duration and type of the client were collected.

Based on the prime communication mode of the current project, respondents were categorized as paper base system users and EDCM system users. Paper based respondents were again categorized into two categories based on their previous experience on the EDCM systems (Figure 2).

Under each category questionnaire mainly contain one free-text question and 16 quantitative questions, of which 13 follows a four-point Likert-scale (Very low, Low, High, Very high).

Sub questions were categorised under main topics such as coordination issues among different parties, security and reliability issues, time taken to search past documents and storage mode of documents and placed in both paper base system users and EDCM system users.

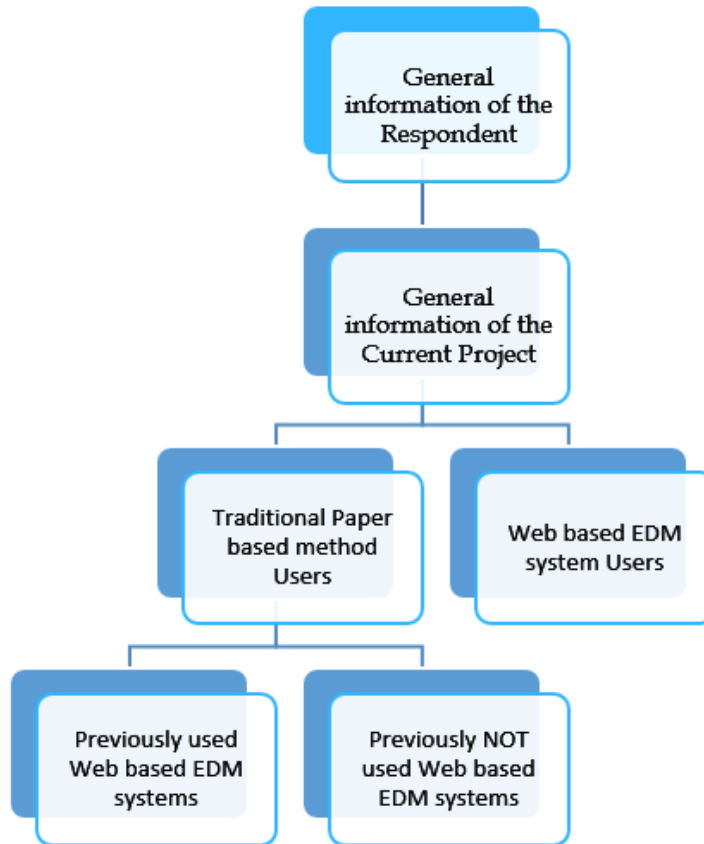


Figure 2 Questionnaire Format

3.3 Pilot Study

The objective of the pilot study is to verify the completeness of the questionnaire. Before distributing the questionnaire, a pilot study was conducted on a limited scale. Most of the respondents agreed that the questionnaire was sufficient to capture the details of document management system available in construction projects. Based on this, the questionnaire survey was finalized.

3.4 Method of Data Analysis

Since the users are categorized into two groups the comparison was carried out using Relative importance index (RII) method. The relative importance index method was used to determine the relative importance of various factors of existing documents and communication management systems.

The participants' responses were rated according to the following rating system to convert the responses into an analytical.

Table 1 Scale used for data measurement

Item	Very low	Low	High	Very high
Scale	1 points	2 points	3 points	4 points

Scores assigned to each question by the respondents were entered and consequently, the responses from all the questionnaires were subjected to statistical analysis. The outcome of two categories of users was obtained by calculating RII (Equation 01).

$$RII = \frac{\sum W}{A*N} \quad (0 < RII \leq 1) \quad - \quad \text{Equation 1}$$

Where:

W- Weight given to each factor by the respondents and ranges from 1 to 4, (where “1” is “Very Low” and “4” is “Very High”);

A – Highest weight (i.e. 4 in this case);

N – Total number of respondents.

4. DATA COLLECTION AND ANALYSIS

4.1 Respondents Background

Responses from different disciplines such as Engineers, Architects, Project managers, Quantity Surveys and Data control officers were received relating to building projects, Irrigation projects, highways and railway projects sponsored by both private clients (local and foreign) and Government sector.

Most of the response received from building sector around 70% (41 out of 58) and all other sectors represent the remaining 30% (Figure 3). From the responses received it can observe that 56% (32 out of 58) of projects are Government funded. The 27% project belong to a local private sector and other 17% funded by the foreign investors (Figure 4).

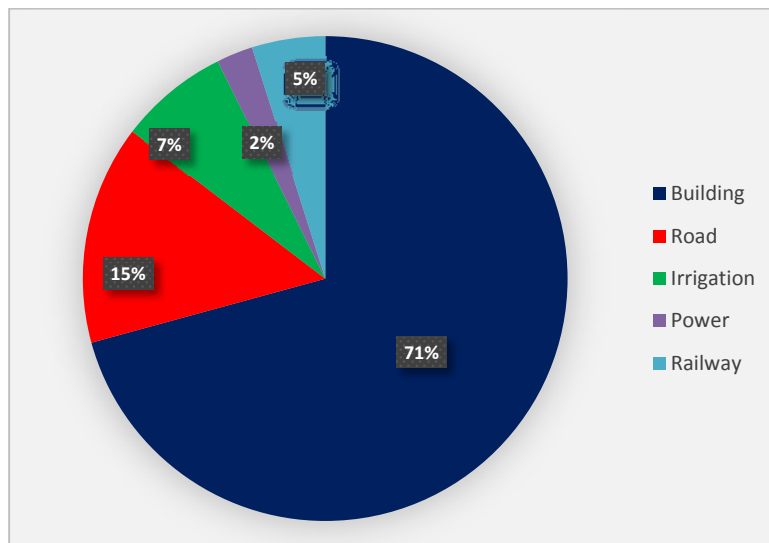


Figure 3 Type of Project

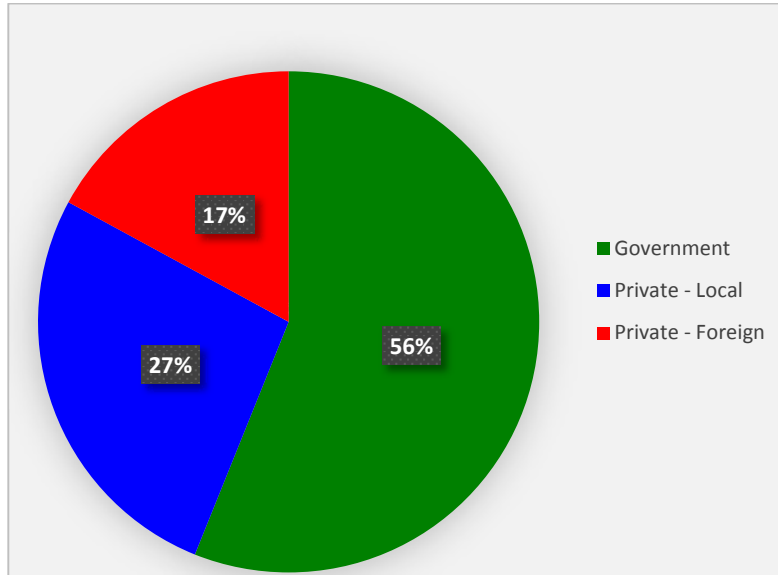


Figure 4 Type of Client

Further, an indication of respondents' roles in the construction sector is presented in Figure 5. Responses received from all three main parties of the construction industry (contractor, consultant and client). For the evaluation purpose it is further divide into two additional sections which subcontractor and design consultant

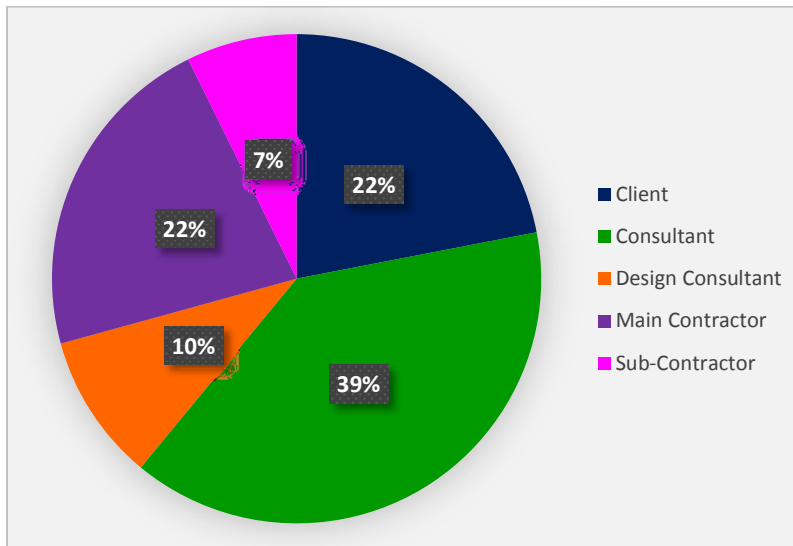


Figure 5 Type of Participant

4.2 Existing Communication System and Previous Experience

Based on the prevailing communication system, all responses were categorized into two major categories as follows.

1. Paper based communication system users.
2. EDCM system users.

It is observed that 56% (32 out of 58) of responses are using conventional paper-based communication system (Figure 6). Further, Figure 7 shows that 65% out of paper-based system users (21 out of 32) do not have previous experiences on the EDCM systems.

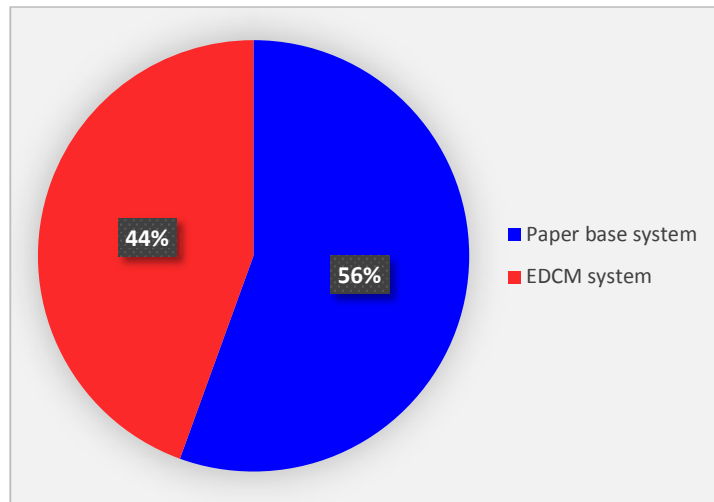


Figure 6 Prime Communication Mode of Project

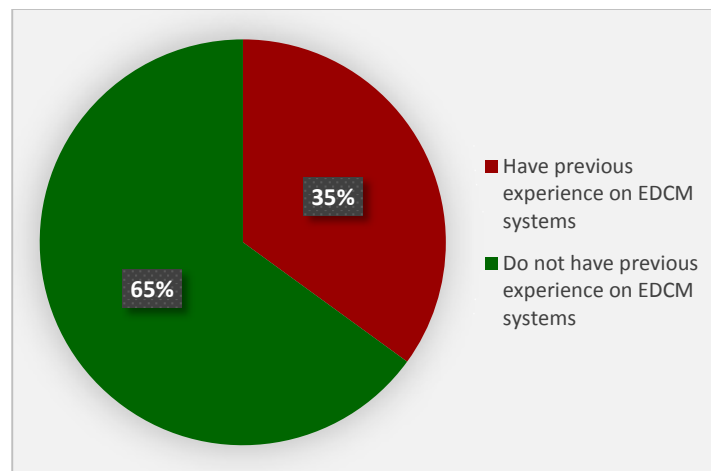


Figure 7 Previous experiences on ECDM

Based on that, it can be concluded that the most of the participant still does not have an experience on electronic system for the communication and documentation process and construction industry still is in a primary stage of adoption of such a system. Further, this illustrate the unawareness level of construction industry about the application of ECDM systems.

4.3 System Security & Reliability

Figure 8 illustrates the comparison of security and reliability issues of two systems. The paper-based document system has slightly higher risks in security than the EDCM systems related to mainly loss of documents and unauthorized access. This is mainly because nowadays almost all the web-based facility providers equipped with high security systems with no chance of unauthorized users or competitors to access the system and data. Further current systems required a user name and password for each and every user to access the system. A paper-based document typically stored in filing cupboards and it is exposed to common users, which is the main reason for the loss of documents as well as the cause for the unauthorized access.

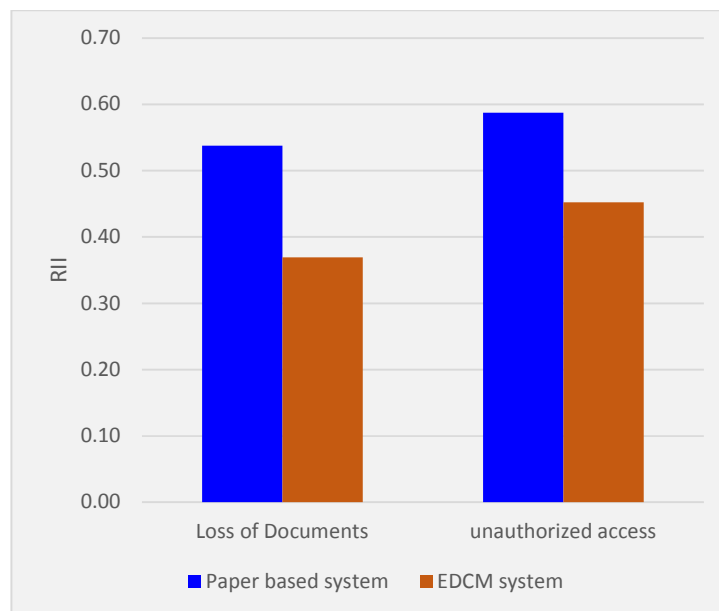


Figure 8 Security Issues

4.4 Legal Acceptance

Since the existing legal system always based on a paper-based contract management environment, it has been engaging some potential risk on the legal acceptance of an online system. It can be clearly identified that most of the people believe paper-based system has much higher legal acceptance and it is way beyond the web-based EDCM systems. Refer Figure 9. Since the internet market place is booming up in other industries, it can be predicted that sooner the jurisdiction system will address the legal issues prevailing in online systems. In addition, most of the web-based DMS contained the documentation's evolution history. This includes information about each document and its status. Traces of revisions, uploading and downloading record can provide a better understanding of who has done what in the system. Since these traces automatically update and logs are computer generated which cannot be easily modified by the project team members these traces and logarithms can be evidence to be submitted to court when there is a major dispute in the project. Further, in project where the electronic web-based system adopted, project specifications provide legal acceptance and validity about the documents transmitted through the EDCM systems.

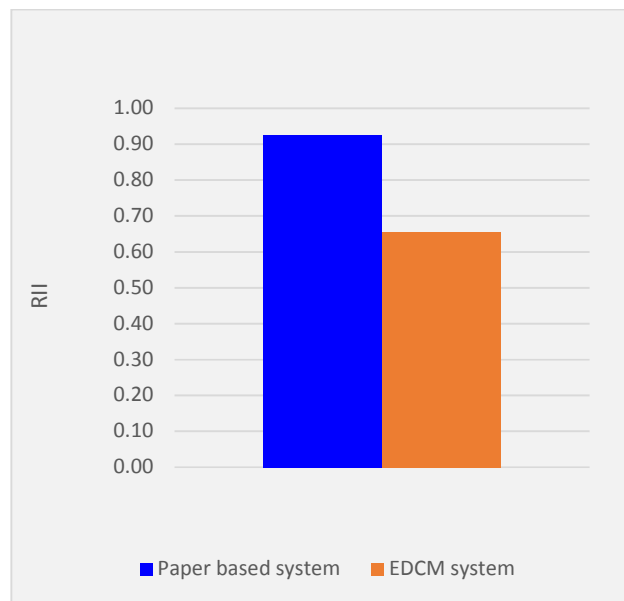


Figure 9 Legal Acceptance

4.5 Facilities Required

Figure 10 explained the requirement of software and hardware facilities and requirements of computer literacy. EDCM systems mainly depend on the Internet and other hardware facilities. When servers shut down, users become disconnected and unable to access the online system, until power restored. Offline access is now a key feature that most of the system providers will offer. It ensures that users can access the key data and get the job done even the connection is slow or lost. Further, both systems required hardware facilities and computer literacy in the same magnitude. Even though the prime communication is paper based system, most of site officers use at least a basic photocopy machine to cater their daily requirement of duplicating copies

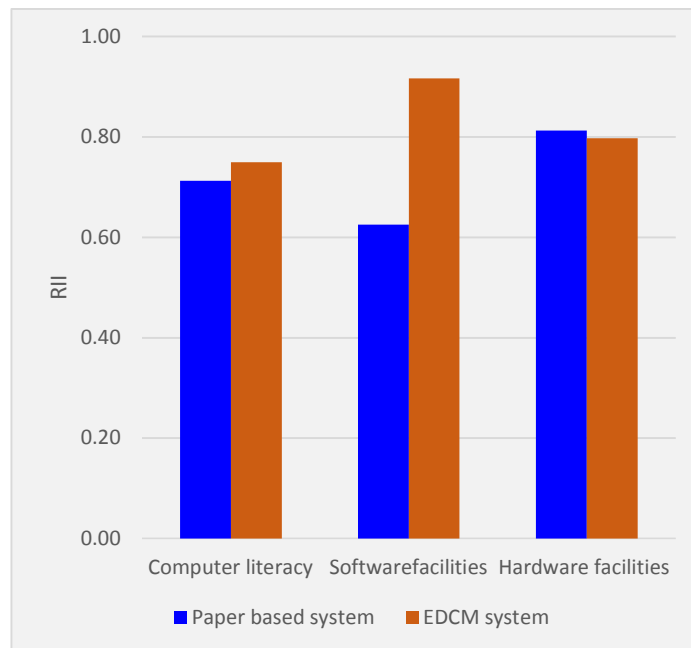


Figure 10 Facilities Required

4.6 Coordination Issues

The web based EDCM system provides online discussion facilities and commenting facilities. This facility accommodates solving disputes and issues arising in the design and construction stage within a minimum time period. When a number of parties are involved in a project, online discussion is much useful and the revised details will be updated on interface of every user. Figure 11 confirmed that the coordination issues arising in paper-based system are

slightly higher than the EDCM system as per the experience of participants in construction management. Furthermore, it can be clearly identified the time taken to solve the coordination is much higher among the paper-based system users. These delays are basically due to lack of information about particular issue and the documents deliver to required officer through several other officers. From EDCM system, the specific details of the matter can retrieve within minute and can discuss the issue with other parties in an online platform which will ultimately deliver solution in lesser time.

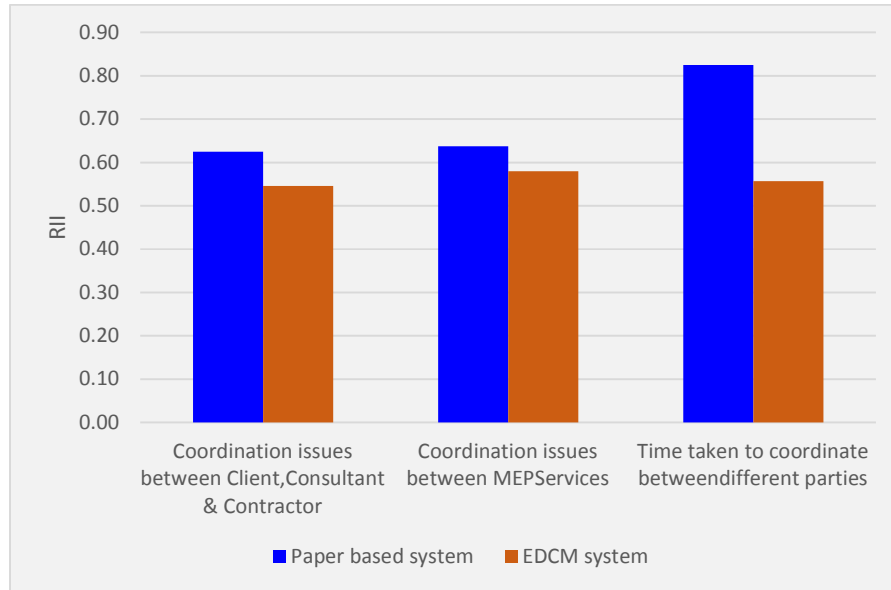


Figure 11 Coordination Issues

4.7 Search of Past Documents

Advance searching is the key facility offers in EDCM system. This feature facilitates users to trace documents more easily, compared with situations where files are located in different locations. Users required to type only the keywords and system will track documents related to key words in time less than a second. Figure 12 confirms the less time consumption to search past projects’ documents in the web-based EDCM system users than paper-based system users as per their experience. Further, EDCM system allows users to attach pointers to documents stored in the system, instead of attaching the actual documents. This allows recipients to get the documents from the system, which ensuring that users refer only the latest approved version.

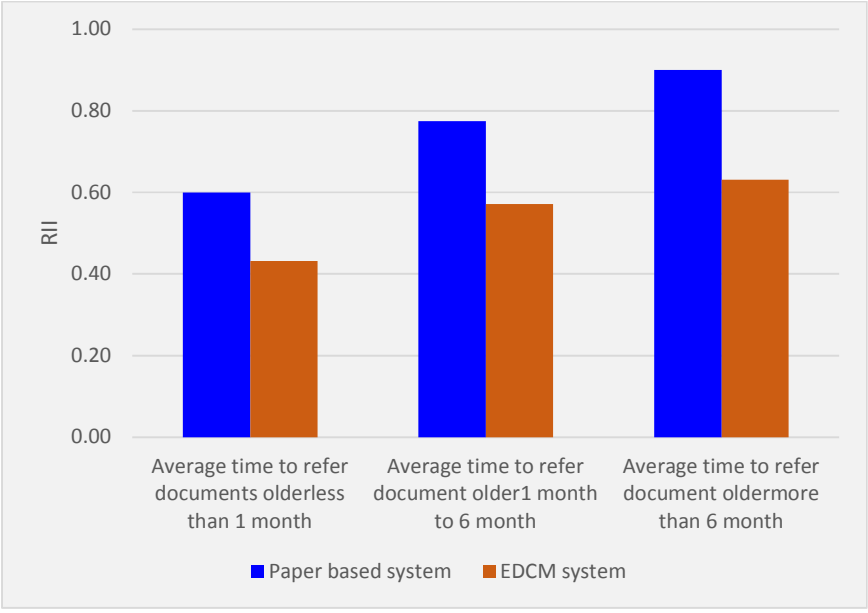


Figure 12 Searching Facility

4.8 Storage Mode

Online systems usually consist of well-organized folder structure that can retrieve files quickly and very easily. All the correspondences are stored in online data based that is provided by the service provider in Web based EDCM system and most of the times, file cupboards are used to store the hard copies of essential documents. (Figure 13) However, access to online data base at a failure of the system is key issue. Some service providers make available offline access to the data base as solution for this issue. File cupboards mainly used by the paper base system users to store hardcopy. These cupboards are accumulating as project run and at the end of the project dedicate specific area for the storage is a problem.

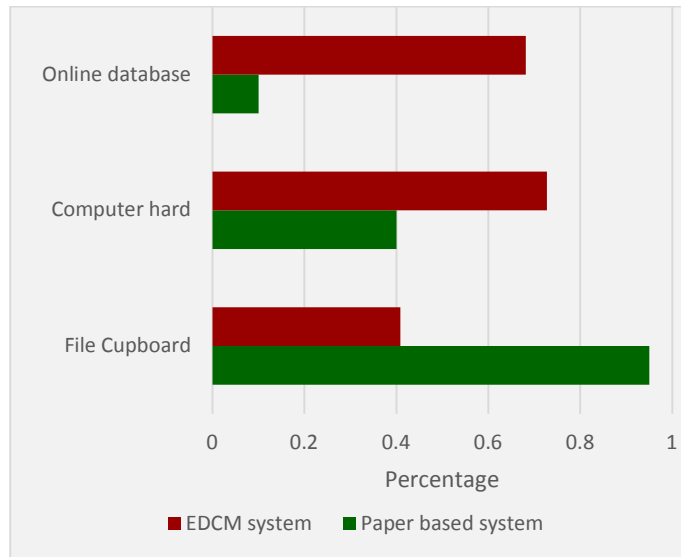


Figure 13 Storage Mode

4.9 Challenges of Implementation of EDCM System

Attitude of top management towards implementation of EDCM system is an immense challenge. Difficulties in quantifying the cost and the benefits of implementation such a system make diminish the motivation of the management. As per the Figure 14, 68% (40 out of 58) believe that the main reason for not adopting a EDCM system is lack of support of top management.

Lack of resources and funds for the implantation is also an issue that needs to be considered. In most of the projects, the budget is not allocating funds for a separate communication system.

Resistance to change is a common issue of adoption of a new system. Figure 7 indicates 65% of paper-based system does not have any past experience in EDCM systems which mean they are new to the electronic systems. System implementation can be caused a considerable organizational change that people tend to resist. Especially this issue can be identified in the government sector.

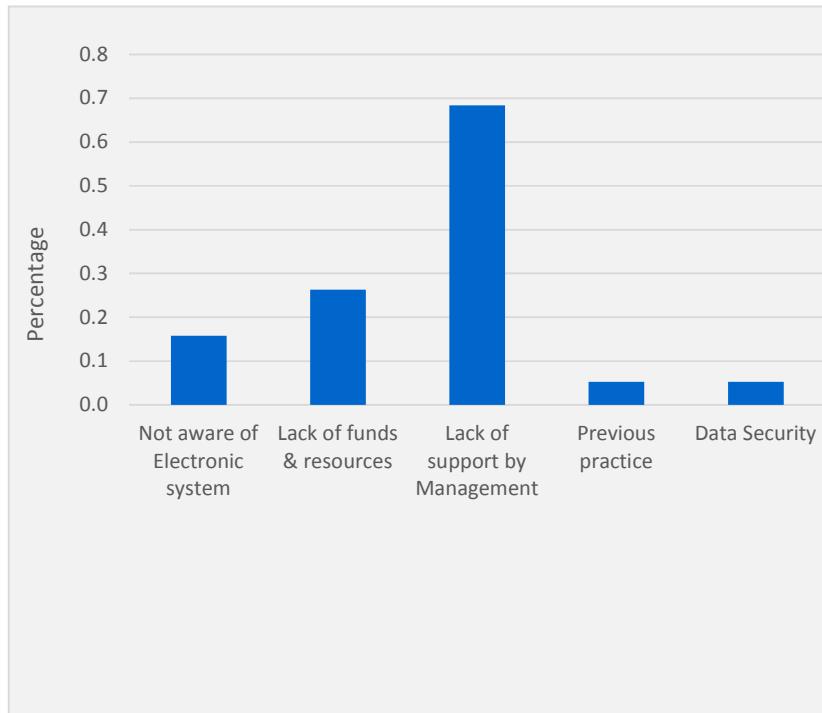


Figure 14 Challenges of implementation EDCM system

From Figure 15, it can be noticed that 100% of private sector projects which has a project value over 10 billion are using an EDCM system as their prime communication mode. In the government sector, it is 100% paper based. It confirmed that it is not experienced such a system even for large-scale projects in the government sector.

Internet access is a prerequisite of web-based EDCM system users and most government organizations have restrictions on their staff for the access of Internet since there may be some misuse. This scenario can demotivate the adoption of web-based systems in the government sector.

Furthermore, data security and legal issues of EDCM can be identified as a resistance for the implementation of such a system.

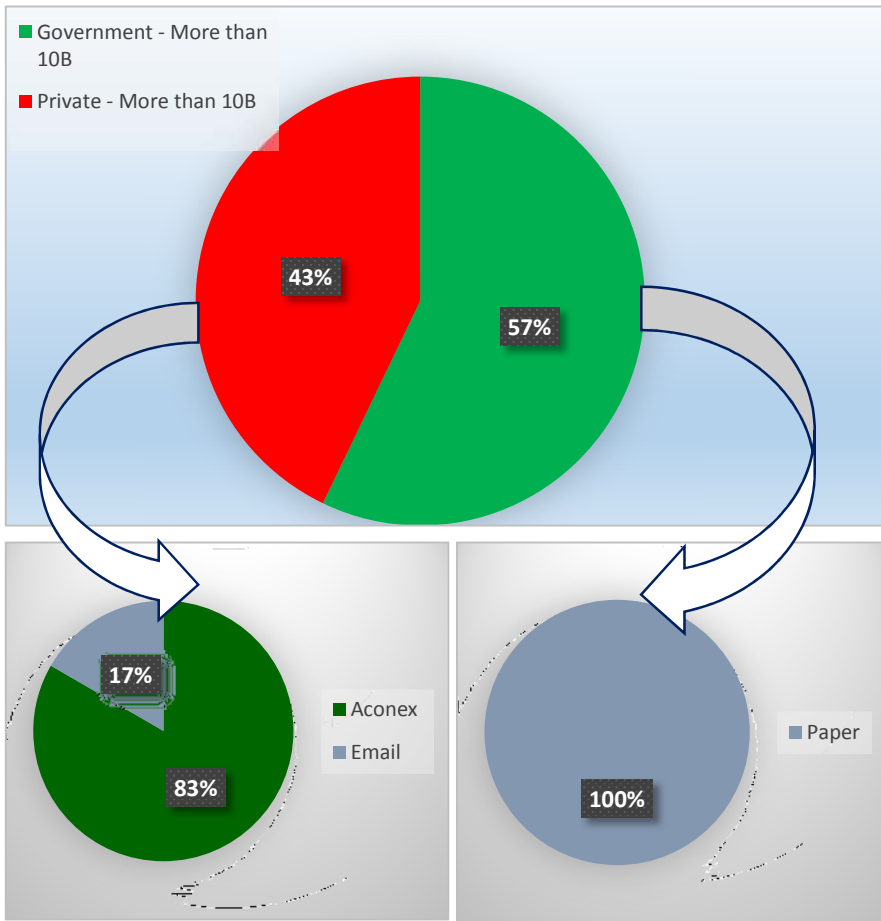


Figure 15 Comparison between Government and Private sector

5. CASE STUDIES OF COMMUNICATION AND DOCUMENT MANAGEMENT SYSTEMS

Three case studies were carried out based on the projects with document and communication management systems to verify the results of the questionnaire survey. Two building projects and one reservoir project were selected and studied comprehensively. Selection of projects was made considering that all three projects represent the stakeholders from the local and the international background. Table 2 illustrates the summary of project details.

Table 2 Stakeholders Background and Project Details

	Project A	Project B	Project C
Client	Government	Government	Private (China)
Consultant	Government	Government	Private (Local)
Contractor	Private (Local)	Private (China)	Private (China)
No. of NSC	2	0	14
Current system	Paper	Email/Paper	Web based EDCM

It is observed that traditional paper-based documentation and communication system has adopted as prime communication mode in project A. Project B used a synchronized version of traditional paper delivery and email circulation method. Dedicated web based EDCM was used in Project C for the communication and documents handling process.

5.1 Project A

5.1.1 Project Description

Project A is a government administrative office building, situated in Narahenpita, Colombo. This project involves the construction of 22-storeyed Building having a total floor area of 28,850 m² with a project cost of 4 Billion. The substructure of the building consists of a single storey basement comprising car parks and superstructure consists of twenty office floors including a rooftop restaurant. Planned project duration is 1095 days and actual duration at present is 1305. Currently project is at the finishing stage and partial handing process is ongoing. Project completion is scheduled to be done by July 2019.

5.1.2 Stakeholders of the Project

Major stakeholders of the project are as specified below. Both design and supervision work were carried out by a single consultant and finishes and most of MEP work were carried out by the main Contractor.

Employer/Engineer: Government

Consultant: Semi Government

Contractor: Private Local Contractor – CIDA Grade Category CS-2 (Highest Grade)

Nominated sub-Contractors:

Installation of Public Address system (PA): Local Private Company

Installation of LAN system: Local Private Company

5.1.3. Current Document and Communication Management System

Traditional paper-based communication and documentation method were adopted for the project A. Communication among the Consultant and the Contractor was mainly carried out by printed letters and the emails were circulated occasionally. Email communication is basically applied for the emergency information transfer and it would not be considered as an

official document until the duly signed hard copy is circulated. Communication between the Client and the Consultant was totally carried out using the printed version of letters.

Due to difficulty in searching past documents, site consultant staff created a tracking system using Excel spread sheets to track the past documents (only for letters) at the midway of the project (Figure 16). Tracking system was named as “Letter Log” and it basically divided into eight main sections considering the order mentioned in IPC (Interim Payment Certificate) such as preliminaries, building works, electrical, mechanical and etc. Each section contains letter date, letter number, letter name, relevant BOQ section, letter origin and the letter receiver and the following actions taken for the particular letter.

Letter Log - Bill No: 03											
Ref	BOQ Item	Section	Clause	Regarding	Date	Correspondence No	Subject	From	To	Action taken	Remarks
Distribution board											
46		3A	2	DB	31/Jul/17	SKDS/ME/593	Variation No. 33 - Supply & installation of new distribution boards	ME-Sanken	AGM-CECB		
Busbar											
50	Busbar	3A	7	Busbar	26/Oct/16	CB/DSC/CS45/SIII/09	bus riser for air condition system	AGM-CECB	ME-Sanken		
51	Busbar	3A	7	Busbar	15/Feb/17	SKDS/AGM/035	Variation no 17 supply and installation of busbar riser system	AGM-Sanken	AGM-CECB		reply for CB/DSC/CS45/SIII/09 - 26/10/16
52	Busbar	3A	7	Busbar	8/May/17	SKDS/AGM/399	Variation no 17 supply and installation of busbar riser system - Rate revision	AGM-CECB	ME-Sanken		
53	Busbar	3A	7	Busbar	22/Jun/17	SKDS/ME/493	Shop drawings submission - Busbar riser system	ME-Sanken	AGM-CECB		
54	Busbar	3A	7	Busbar	3/Jul/17	CB/DSC/CS45/SIII/09	Shop drawings submission - Busbar riser system	AGM-CECB	ME-Sanken		
55	Busbar	3A	7	Busbar	26/Jun/17	SKDS/AGM/035R	Variation no 17: supply and installation of busbar riser system (Revised)	AGM-Sanken	RE-CECB		
56	Busbar	3A	7	Busbar	3/Jul/17	CB/DSC/CS45/SIII/09	Shop drawings submission - Busbar riser system	AGM-CECB	ME-Sanken		
57	Busbar	3A	7	Busbar	4/Aug/17	CB/DSC/CS45/SIII/33	Variation no 17: supply and installation of busbar riser system (Revised)	AGM-CECB	Client		
Cable											

Figure 16 Letter Log – Project A

5.1.4. Volume of Documents Transferred.

Table 3 illustrates the document types adopted in project A for the communication between different parties and volume of the transmitted documents. Letters relevant to the different discipline were circulated under a separate numbering system and RFI, Verbal orders, Site instructions, Quarry sheets and Inspection sheets mainly categorized in to Civil and MEP. Table 3 does not include the amount of the drawings transmitted among each party and the number of inspection sheets transmitted due to the unavailability of data.

Table 3 Volume of documents transferred in Project A

Document Name	No. of Documents	From	To
Contractor's letter	2172	Contractor	Consultant
Consultant letters	2160	Consultant	Contractor
Resident Engineer (RE) letter	1131	RE	Contractor
Consultant letters to client	754	Consultant	Client
Site instruction (Civil)	252	RE	Contractor
Site instruction (MEP)	65	RE	Contractor
RFI MEP	354	Contractor	RE
RFI Civil	65	Contractor	RE
Contractors AGM Letters	214	Contractor	Consultant
Transmittal	753	Contractor	RE
Verbal order Civil-51	51	Contractor	RE
Verbal order MEP – 50	50	Contractor	RE
Query sheet (Civil)	62	Contractor	RE
Query sheet (MEP)	29	Contractor	RE
Total Documents	8112		

Almost all the letters transmitted from one party to another party were copied to another two parties. Hence, the total number of printed documents shall be much higher than the total number mentioned above.

5.1.5. Observations on Current system

As per the discussion had with the resident consultant staff, the major challenge they have encountered was the maintaining a real time communication among the consultant side itself with minimum latency. Most of the time, required instructions got delayed because of the documents transmit to relevant individual, passes through several other parties. Further, it can be observed that there are several duplications of documents in each stage.

As an example, the RFI regarding Air-conditioning system installation first submits by the Contractor to the RE office in the construction site. In RE's office, the original document is filled and RE addresses the issue to the project management division (PMD) in head office by writing a minute on the photocopy. If documents contain only few A4 pages, it is transmitted by the mode of FAX and if the document is large or contain A3 pages, it is sent by the vehicle on the same day or the following day. In PMD, the document is photocopied and addressed the issue to particular officer by writing a note on one copy while keeping the other copy with the division. The particular officer photocopies the document and writes the answer to the query on one copy and sends back to PMD while keeping the other copy with him. PMD division keeps a one copy of document with them and sends other copy to RE office by a vehicle or as a FAX. Once the answer is received, RE takes a photocopy of the original RFI and writes the answer on it and transmits to the Contractor's office. Documents received from PMD is filled with original RFI. This cycle process and delays in each stage are illustrate in the Figure 17.

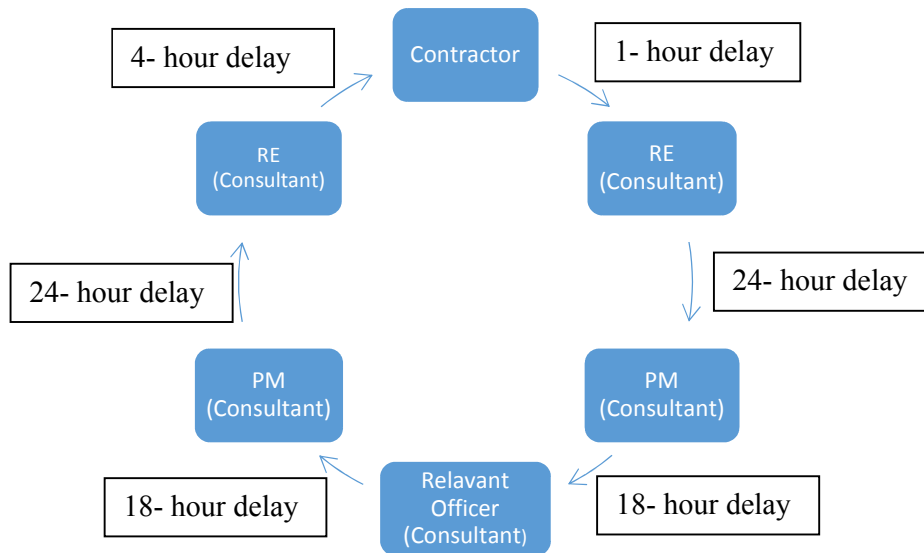


Figure 17 Process of Document approval in Project A

Delivery times of letters in each stage were measured from the time indicated in the letter delivery books and date-seal copy. Delays occurred in each stage were calculated based on the delivery time and average delay times were taken for one-week period to ignore the delay occurred due to special circumstance.

The whole process takes around 4 days without including the review time of relevant officer. Site Engineer in RE office stated the above-mentioned process (including the review time of documents) took average 7 days and more than that especially when the query is referred to more than a single officer. The main cause is the conventional systematic process that is practiced in the government office. The worst case is that PMD and other offices are closed during the weekend and public holidays (except RE office) resulting a further delay.

Another issue identified at the site is difficulty in searching old documents and loss of documents. It creates a delay in responding to letters within allocated time period and critical issues were occurred due to missing letters. A staff member in the site office mentioned that there was misplacement of some important documents while shifting the site office from basement level to 12th floor to accommodate the finishing work of the basement. Although, the Letter Log created some convenience, loss of documents before data entry process and difficulty to track the past project documents other than letters would create huge problems in site supervision and administration process.

Difficulty in site supervision due to the unavailability of the latest document was also observed as a critical issue. The technical staff was not aware about the latest approved version of documents or drawing if there were some revisions.

Further, difficulty in space allocation for file cupboards which contain past documents were identified as a considerable issue especially at the latter stage of the project.

It can be observed that there is no dedicated document controller employed for the RE office and all correspondence were handled by the site technical staff.

5.2. Project B

5.2.1. Project Description

The Project B is located in Matale, Central province of Sri Lanka. The main purposes of the project are releasing water for irrigation requirements for 400 Ha and transferring 100 MCM of water annually to supplement the water requirement of the adjacent reservoir.

The reservoir capacity is 248 MCM with two rock fill dams with a clay core called Main Dam and Saddle Dam. The project is at the final stage and scheduled to hand over in July 2019. Planned Project durations was 1395 days and actual duration was 1613 days. Estimated Project Cost is Sri Lankan Rupees 13.0 Billion.

5.2.2 Stakeholders of the Project

Three major parties were involved in this project as follows.

Client: Government

Engineer/Consultant: Semi Government

Contractor: Foreign company

5.2.3. Current Communication and Document management system

The prime communication mode of the project B was transmitting paper-based correspondence. Around 1500 letters per year were circulated between the client, the engineer and the contractor covering all the aspects of the project. Even though the prime mode is paper transmittal, it can be observed that each and every document initially circulated by emails.

The Engineer's team introduced a Letter management system named "Letter Catalogue" created from the google spread sheet. Though it was not adopted by the client and the contractor, the system was maintained by the project management division of the engineer's side to track the past letters and their status (Figure 18).

DATE	REFERENCE	FROM	TO	SUBJECT	PREVIOUS LETTER REFERRED	FIELD	RESPONDED DATE
2-Jan-18	L-K-CON-2018001	PM(SHC)	TL(CS)	Submission of Construction Weekly report (issue no.176)		Report	
2-Jan-18	L-K-CON-2018002	PM(SHC)	TL(CS)	Submission of the method statement of concrete works for TCO & LBO & BO gate house for gate shafts		CON	11-Jan-18
3-Jan-18	L-K-CON-2018003	PM(SHC)	TL(PMD)	Relevant issues about SPW control section		HM	12-Jan-18
3-Jan-18	L-K-CON-2018005	PM(SHC)	TL(PMD)	Reply to Potential Suppliers Qualification Documents of Electrical Equipment	CECB KALU/PMD/SHC/2017592		
4-Jan-18	L-K-CON-2018006	PM(SHC)	TL(CS)	Submission of instrument monthly (December 2017) report		Report	
4-Jan-18	L-K-CON-2018007	PM(SHC)	TL(CS)	Submission of weather monthly (December 2017) report		Report	
4-Jan-18	L-K-CON-2018008	PM(SHC)	TL(CS)	Reply to your letter CECB-KALU-CSU-2018002	CECB KALU/CSU/2018002	Read	11-Jan-18
4-Jan-18	L-K-CON-2018009	PM(SHC)	TL(PMD)	Clarification about PLC system of hydraulic hoist for			

Figure 18 Letter Catalogue - Project B

5.2.4. Reasons for the Adoption of Letter management system.

The management team, design team and the project management division of the Engineer's team located in Colombo and the Engineer's site construction supervision team located in the site which is around 250 km from the Colombo, creating a practical difficult to handover printed version of documents. Further, many issues were arisen due to the absence of a proper document control and management system such as difficulty in searching and monitoring past documents. It resulted a big communication gap and delay in responding. Lack of funds to purchase a dedicated software was also motivated them to create a basic letter management system for the project.

5.2.5. Volume of Documents Transferred.

The Engineer's team consists of mainly three parties such as management team, Project Management and Design team (PMD) and site construction supervision team (CSU). Contractor mainly communicated with CSU and PMD. All three parties of the Engineer's team individually communicate with the Client. Summary of volume of documents transferred in shown in Table 4.

Table 4 Volume of documents transferred in Project B

Document Name	No. of documents	From	To
Contractor's letter	5173	Contractor	Engineer
Consultant's letters	4731	Engineer	Contractor
Consultant's letters	1218	Engineer	Client
Total Documents	11,121		

Copy of each document circulated to other parties in every transmittal. Consider an example a letter that PMD division addresses to the Contractor. The letter is copied to site construction supervision unit, Engineer's head office and Client's office. Hence, each document approximately copied to another three offices, created huge number of duplications.

5.2.6. Observations on Current System

PMD in Colombo has the sole authority of creating and managing of letter management system. As mentioned by the office Engineer in PMD who involved for the creation of the system, initially it was demonstrated in site meetings and modified according to the comments from senior consultants. Then the system was run as a pilot project and finally implemented.

Letter log contains the date, letter number, subject, from which party to whom and reference letter numbers with action taken. PDF version of letters were uploaded in to Google drive separately and link with the letter log.

Office Engineer mentioned that there were few difficulties at the initial stage of implementation. Some senior officers in government not much familiar with the system and Officers of PMD personally assist them in this situation.

The system served the purpose well and team leader led internal meetings based on the letter catalogue. Not only that this saved the precise time of the staff but it was also a cost saving to be spent on modern software dedicated for communication. Following the same concept, a

progress photo catalogue (Figure 19) and a drawing register (Figure 20) was created which also became essential components in managing the project.

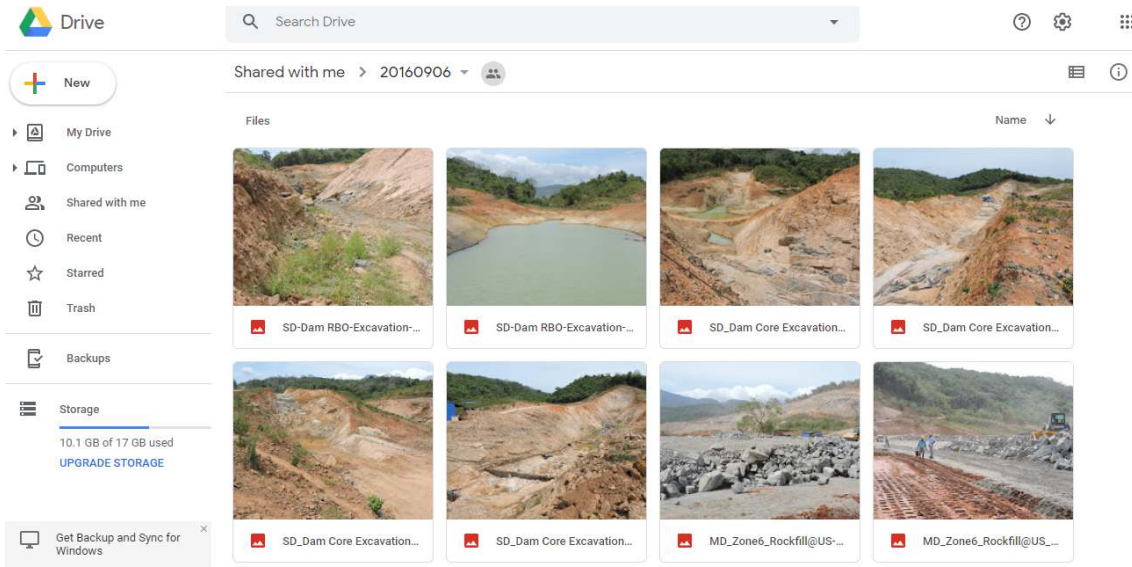


Figure 19 Photo Catalogue - Project B

New Drawing register for KGDP.xlsx

File Edit View Insert Format Data Tools Add-ons Help

100% View only

DWG REGISTER OF KALU GANGA DEVELOPMENT PROJECT														
No	DWG No	DWG Title	Status of Issued	Discipline	Issue Date	Rev 01	Rev 02	Rev 03	Rev 04	Rev 05	Status	Responsible person/s	Remarks	
1	<i>Dwg No. as mentioned in the dwg.</i>	<i>Dwg Title as mentioned in the dwg.</i>	<i>Status of Dwg</i>	<i>Discipline of the dwg should be mentioned</i>	<i>Dwg issued date</i>	<i>Rev 01 Dwg issued date</i>	<i>Rev 02 Dwg issued date</i>	<i>Rev 03 Dwg issued date</i>	<i>Rev 04 Dwg issued date</i>	<i>Rev 05 Dwg issued date</i>				
2			Issued	- GA-General arrangement										
3			To be Issued	RF-Reinforcement										
4			On Progress	- Misc - Miscellaneous										
5				- SEC-Section										
6				DN-Plan										

Legend Staff GEN MD-GEN MD-Dam Body MD-Spillway MD-DT TCO LBO BO

Figure 20 Drawing Register - Project B

After mid stage of the project PMD recruited dedicated documents controller for the document management. Further, staff in this project always take printout of each transmittal and filled in the cupboard as a backup in a possibility of data loss.

5.3 Project C

5.3.1. Project Description

Project C is a residential building complex situated in the heart of the commercial capital of Sri Lanka. Housing capacity for more than 2,000 individuals in an area across 140,000m², the project will consist of 4 towers with a total of 41 floors, which will feature 608 luxury apartments. Planned project duration was 900 calendar days and actual project duration was 1580 days and scheduled to be handed over by July 2019. Estimated Project Cost is 20 Billion Sri Lankan Rupees.

5.3.2. Stakeholders of the Project

There are several foreign and local parties involved in the project as specified below.

Client/Engineer: Foreign Company

Architect: Private Local Company

Design Consultant: Private Local Company

Supervision Consultant: Semi Government

Quantity Survey: Private Local Company

Contractor: Foreign Company

Nominated sub-contractor:

Piling: Private Local Company

Electrical: Private Local Company and Foreign Company

LP Gas: Private Local Company

Medium voltage Distribution: Private Local Company

Fire Alarm & Detecting System: Private Local Company

Elevator and escalators: Private Local Company

Power Generators: Private Local Company

Metal work and Glazing system: Foreign Company

Architectural finishing works: Foreign Company

Extra low voltage system: Private Local Company

Sanitary fittings & fixture: Private Local Company and Foreign Company

Pantry cupboards & Wardrobes: Foreign Company

5.3.3. Current Communication and Document Management System

Project C management team incorporated a dedicated software namely “Aconex” for the document management and communication purpose. Aconex Limited was an Australian company providing mobile and web-based collaboration technologies for project information and process management to clients in the construction, infrastructure, power, mining, and oil and gas sectors. Aconex provided the most widely used cloud-based, multi-company project collaboration solutions for construction and engineering.

Aconex software basically provides documents control, workflow management, and report generation and email facilities among users. Further Aconex act as a search engine of past project documents and emails and facilitate with advance searching by applying several filters. In addition, the advance version of Aconex provides BIM management and bidding and tender process management.

Administration work of the system carried out by the Client. Each party involved in Project including nominated sub-contractors have a one or more user account to access the system. Each of the user has to enter a username and password to access the system. Each user can access to their own interface which connected by a common platform.

5.3.4. Reasons for the Adoption of Web based EDCM System

Since there are several parties involved in the project C, smooth flow of documents and communication among parties is a key challenge. Further, head office of client, main contractor and some nominated subcontractors located in China and base station of other consultant and contractor are located in Sri Lanka. Hence real-time communication among these stakeholders are essential and EDCM system can cater this requirement in addition to other facilities inbuilt with this system.

Crucial challenge of a project is completion of construction of 4 towers each of 42 stories within 900 calendar days. Hence, the contractor needs to adopt a speedy construction process, sometimes continue 24 hours working agendas. In this ground, proper communication is much essential and delay of any document of instruction will create more complication. Therefore, the Client uses a web-based EDCM system for ensuring proper communication and avoid delays in issuing instruction for the smooth flow of the project.

5.3.4. Volume of Documents Transferred.

Table 5 show the quantity of documents transmitted within each party. Technical documents, reports, letters, RFIs and drawings mainly submitted by the main contractor and all other sub-contractor. Client and other consultant review the document and give feedback to relevant party by format of “Engineers instruction” or by letters.

Table 5 Volume of documents transferred in Project C

Document Name	Quantity	From	To
Instruction from Engineer	4460	Client	Contractor
Letters	7672	Client	Consultant/Contractor
RFI	423	Contractor	Client/Consultant
Reports, letters and drawings	10010	Main Contractor NSC contractor	Client
Total	22565		

Since there are several numbers of parties from different discipline involved in a project, higher volume of documents transmit can be observed

5.3.5. Observations on Current System

As per the discussion had with officers in the client office, at the initial stage of the project, system developer gave a free demonstration and training to all users of the system, which help first time users to familiarize with the process. Even though the training was successful,

there were some mistakes while numbering the documents, carbon coping (CC) to other parties and responding to the assigned task at the first few days. However, with a short period of time, all the users are well familiar with the basic function of the system.

Figure 21 shows the platform which enables the users to transmit a document, mail, work flows and view their outstanding task. Dedicated document control officer located in client office, manage the system such as initiating work flows and assign tasks.

The screenshot displays the Aconex 'Upload Document' interface. At the top, there is a navigation menu with options: Tasks, Documents, Mail, Tenders, Workflows, Directory, and Setup. Below the menu, the 'Upload Document' form is visible. It contains the following fields and values:

Document No *	ELEC-0002	Revision *	A
Title *	Lighting Layout - Main Lobby	Type *	Drawing
Status *	Approved	Discipline *	Electrical
Building Zone	Events Centre	Work Package	
Confidential	<input type="checkbox"/>	File	Choose File No file chosen
Print Size		Revision Date *	19/02/2015
Created By		Comments	

Figure 21 User Interface in Aconex

Once a document is submitted by the contractor, documents controller initiates a workflow and refer to relevant consultants seeking comments on the documents by assign tasks. The Consultant need to provide his opinion with or without his comments.

For an example, let's consider a method statement of concreting works. First contractor uploads the soft copy of the document (PDF version) to the system and forward to the client's approval. Then the document controller creates a workflow and refer to the structural Engineer and Supervision Consultant for their approval. There is a specific time period to a consultant to comment, and the deadline is indicated in consultant interface as a pending item. Once all the consultant sends their comment to the Client, final decision circulates to all the users involved in the project (Figure 22).

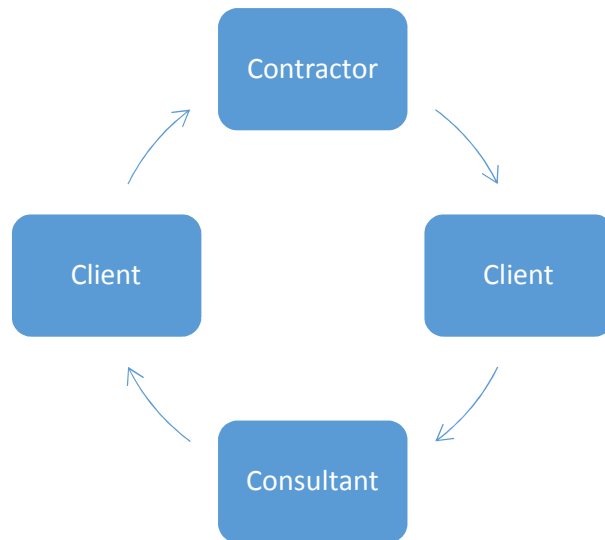


Figure 22 Process of Document approval in Project C

This online process is very simple as well as fast. All the parties can access to the system even they are physically not present at the work station. Hence, public holidays and weekends could not delay the documents flow. Further, all the correspondence transmitted through the system has legal appentence and it is clearly mentioned in the project specification.

Advance searching is a key facility provided in the web-based EDCM system. There are many filters that can apply while searching which can track the past documents very quickly without any difficulty. All the parties agreed that, it is very easy to track the latest version of any documents or drawing with this facility.

Civil Engineer from the supervision consultant mentioned that they are really benefited by the system as they can assess to the documents database even from the mobile phone while conducting inspection. However, he further states that they share the username and password among all the Engineers as there are only limited user account created for a particular party which create a risk of data security.

An officer from the Quantity surveyor team mentioned that the biggest challenge was to access the data base during a power failure or an internet failure. Hence, he suggested to have a mechanism that can access to the data base even in the offline situation.

It is observed that most of the consultants and the contractors take printouts of each document transmitted through the system which is not a usual practice of the EDCM system. During the

discussions it was identified that the main reason to take printout is lack of confidence on system as users think there is some probability for data loss. Further, it is identified that the most of technical staff prefer to follow a hardcopy instead of a softcopy as they believe that reading hardcopy would give a proper gravity of the document content. This will lead to take multiple printout of the same copy by different users.

5.4. Summary of Case Studies

Three projects discussed above demonstrate the communication and document management systems mainly prevailing in the construction industry. Table 6 summarized the overall nature of three project.

Table 6 Summary of Project details

	Project A	Project B	Project C
Nature of the project	Building	Reservoir	Building
Cost of the project (LKR)	4 Billion	13 Billion	20 Billion
Estimated Duration of the project (days)	1095	1395	900
Actual Duration of the project (days)	1305	1613	1580
No. of stakeholders (including NSC)	5	3	20
Dedicated documents controller	No	Yes	Yes

It can be observed that project A is the smallest in project cost while project C is the highest. High number of parties involved in project C compared to other two projects. Both planned and actual durations exceed 900 calendar days in all three projects.

Above mentioned case studies expose that traditional paper base documentation create more coordination issues compared to projects which use EDCM systems, despite the project is small in scale and most of the stakeholders located nearby each other. Hence, it can reveal that advantages of adoption of EDCM for the construction project outweigh the disadvantages. However, level of adoption can be decided base on the scale of the project. Further, it can be observed that the Client's influence is much higher in all three projects while selecting of the mode of communication and documentation for a construction project.

Table 7 summarized the advantages and disadvantage observed in communication and document management systems in each project.

Table 7 Summary of advantages and disadvantages on document management system

	Advantages	Disadvantages
Project A	<ul style="list-style-type: none"> • No need of additional equipment. • No effect by internet failure. • No additional cost for the dedicated documents controller. 	<ul style="list-style-type: none"> • Not responding letters within allocated time period • Difficulties in finding the final state of the issues • Issues emerged due to missing letters • Letters were not delivered to relevant parties • Difficulty in site supervision due to unavailable of latest document. • Duplication of documents. • Space allocation for documents storage.
Project B	<ul style="list-style-type: none"> • Speed transmittal of documents • Low cost than dedicated software • Speed searching process of past documents. • High accessibility (from Mobile Phone) 	<ul style="list-style-type: none"> • Duplication of documents. • Space allocation for documents storage. • System get hold in breakdown of Internet facility • System get hold in power failure
Project C	<ul style="list-style-type: none"> • Quick response to request of information (RFIs) • Speed searching process of 	<ul style="list-style-type: none"> • System get hold in breakdown of Internet facility

	<p>past documents.</p> <ul style="list-style-type: none">• High accessibility (from Mobile Phone)• Less duplication of documents• Ability to assign task with• Less space is required for the storage• Possibility of tracking response time and task achievement	<ul style="list-style-type: none">• System get hold in power failure• Cost of Training of new users• Cost of creation of user accounts• Paper wastage and printing cost.• Dedicated document controller required.
--	---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------	---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------

6. CONCLUSIONS AND RECOMMENDATIONS

6.1 Conclusion

This research was focused on the adoption of EDCM systems in the construction industry. The EDCM systems possess many features that need to be evaluated and further, there are potential benefits and impediments for the implementation of such a system to be discussed.

It can be concluded that successful implementation of EDCM system provides significant benefits mainly in coordination with different parties, data security and advance searching. Real benefits can be observed when a considerable number of parties around the world are involved in the project. Apart from above mentioned benefits, fully equipped web-based EDCM system provides various facilities. Allowing project members in worldwide to create and review documents from any location, online communication, BIM integration can be identified as some key features these systems equipped with apart from its typical facilities.

The main disadvantage of the system is the dependency on internet and computer facilities and the whole system will get clogged when the servers are down. Some of the service providers offer daily backup of data system which incurs some additional cost.

According to the findings, legal acceptance of EDCM system is moderately arguable. Even though, most people believe that electronic system does not have a valid legal acceptance, now a days most project specifications address the question in favor to the EDCM systems.

Attitude of top management towards implementation of a new system is a key barrier apart from several other influences. Resistance to change is a common issue for implementing a new system over the existing one, since most of the people do not aware of the web-based EDCM systems and their facilities. Apart from that, high initial cost can demotivate implementing such systems for small scale projects.

It is observed that Government sector is more reluctant to implement an EDCM system for the construction industry than a private sector. Almost all the private sector large scale projects adopt web-based EDCM systems as the prime communication method which leads to successful project management.

There are many other factors to be considered when implementing an EDCM system for a new project rather than cost of implementation, such as level of security provided by the facility providers, legal acceptance and technical issues.

Difficulty in quantifying the cost and the benefits of implementation of EDCM system is the main disadvantage in assessing such a system for a project.

Case studies were carried out to compare the three different communication and document management systems prevailing currently in the construction industry.

Case study carried for the project A clearly shows that there are considerable disadvantages of use of paper-based system despite having some minor advantages. Use of paper-based system emerged some critical issues due to missing letters such as difficulties in finding the final state of the issues. This creates a difficulty in site supervision due to unavailability of the latest document. Further, letters and instructions were not delivered to relevant parties and delaying responding to requests can be identified as a major shortcoming. In addition, in conventional paper-based system, considerable amount of duplications of documents are produced and storage of documents consume a substantial amount of space. However, use of traditional method for the communication is not required any additional equipment which results no additional cost.

Case study carried out for the project B shows that the use of traditional paper-based method for communication is not practical when major stakeholders of the project are located in different locations. Project B is an example for using a harmonic version for communication and documents handling with both traditional and electronic systems. The main advantage of this method is speedy transmittal of documents with low cost than a dedicated software. Further, use of email transmittal method creates high accessibility and user-friendliness. In addition, the requirement of dedicated documents controller is not there due to the simplicity of the email transmittal system. Duplication of documents and dependency on internet facility can be identified as some disadvantages in this hybrid version.

Considering the requirement of speedy communication due to the tight project schedule and the many number of stakeholders of the project located in worldwide, a dedicated software is used for the communication and documentation in project C. As expected, progress of construction work was not delayed due to problems arisen at construction stage since all parties (client, consultant, contractor and sub-contractor) were linked together by a dedicated software. Further, this mechanism facilitates speed searching processes of past documents and high accessibility (from the mobile phone). The unique feature is ability to assign tasks for the users to complete with the defined time frame and monitor the progress. However, it is observed that all the functions provided by the system are not used in project C. Major disadvantage is getting hold the system in a breakdown of power or internet. Cost involved in

creating user account demotivates the client to move towards purchasing of this kind of dedicated software. Even though it is required a dedicated person to handle the system, it facilitates the smooth flow of the system. As per the study, many people believe that there is a lack of legal provisions in EDCM systems. However, as per the comments of the system users, the EDCM system provides more legal acceptance as it contained the documentation's evolution history and current status of each document. Case study carried out for Project C further reveals that even though the electronic system adopted for the communication process, still system users print most of the documents considering the risk of documents loss and the convenience of reading a hardcopy for better understanding. This will lead to take multiple copies at the same time by different users.

Based on the case studies, it can be concluded that all three systems have their own advantages and disadvantages. Adoption of EDCM system for the construction project provides considerable benefits in terms of coordination, especially when the project stakeholders are not located in the same place. However, the drawback is the inability of operating the system at a breakdown of power or internet. In addition, use of a combined mechanism of transmittal of email and hardcopies whenever required are provided moreover similar advantages as a dedicated system if the number of stakeholders involved are less and the project communication flow mechanism is not much complicated.

6.2 Recommendations

Based on the above-mentioned findings of the study, following recommendations were suggested.

Implementation of a web-based electronic system for document management and communication will bring considerable advantages. In order to have efficient and smooth communication in construction technology, the Contractors, Clients and the Consultants shall take steps to adopt information technology to construction projects. Incapability in quantifying the benefits and cost is a significant barrier to decide which projects are suitable to adopt an EDCM system. However, as discussed, mega projects which include higher number of parties from different places mostly around the world can experience real benefits of this implementation.

It is recommended to implement these EDCM systems at the very beginning of a project where the high value to the project can be added. The system implementation reduces communication difficulty among different parties and allows data sharing directly between the design and construction team eliminating a considerable barrier in increasing productivity in construction sites.

However, technology can create underperformance or interruption at unexpected situations. Adopted electronic system might have its own bugs, difficulties or loopholes. One of the major issues is system crashes and malfunctions. Hence, organisations or projects adopting the EDCM systems should set-up emergency plans for system breakdowns. Off-line system back-up will be a suggestion as a contingency plan. Automatic daily system back-up is the best solution, but it will incur additional storage space for computer servers. In addition, it is recommended to consider the systems that can be accessed both on-line and offline.

Most of the project specifications mentioned about legal acceptance of online communication. However, people still in doubt about the legal acceptance of the EDCM systems. Hence, it is suggested to relevant authorities to organizing awareness sessions such as seminars or workshops to the stakeholders in construction industry on this topic. Service providers can take initial steps in organizing these activities to increasing the awareness in the industry.

Human behaviour and their resistance to change are barriers in adopting these electronic technologies over traditional methods. Usually, the middle management takes initial steps to find ways to enhance the time, cost and quality of a construction project. Senior management of companies relies heavily on numbers. As mentioned above, due to incapability in specifying the exact value of profit gain through adopting a new system, it is difficult to convince the senior management for this change. Without personally experiencing the well-being and advantages of these systems, it is rather difficult to urge them to invest a good sum of money from the company profits to such a system. This will become the first hurdle in implementing a collaboration system as a whole. Even if the companies have decided to invest, they need a proper action plan to ensure that the benefits of adopting these systems are carefully communicated to their staff as well as other project team members.

Young professionals are most adaptive for advancement in technologies and the most enthusiastic to try new innovations. Hence, it is suggested starting introduction and training targeting them on these systems since university period such that they are very familiar with these systems when they start to practice in the construction industry.

Most of the EDCM system users still print the hardcopies of the document. Hence, it is recommended to establish a proper coordination among users prior to take printouts to optimize producing duplications. Further, it is recommended to adopt proper filling system for hardcopies that can access by other staff straightforwardly, which can save the cost and time both.

Most of the people believe that EDCM systems need funds and resources for the implementation. Even though it is true that the initial cost of adoption is much higher than the conventional system, real benefits can be experienced at the completion of the project. Implementation of electronic system for communication and document management brings not only easy access to information but also possibility in reducing their overhead cost as it costs manpower and capital in every passing minute of a construction industry.

Reducing carbon foot print is one of the major intangible benefits that each and every one in the world can sense by moving to a paperless environment. On the other hand, disposal of electrical items needs to be carried out in a proper manner when using electronic system without causing damage to the environment.

REFERENCES

- Ahmad, h. S., bazlamit, i. M., & ayoush, m. D. (2017). Investigation of document management systems in small size construction companies in jordan. 7th international conference on engineering, project, and production management (pp. 3-9). Elsevier.
- Alshawi, m., & ingirige, b. (2003). Web-enabled project management: an emerging. Automation in construction (pp. 349-364). Salford uk: school of construction and property management, the university of salford.
- Astor, j. (2017, march 20). Top 3 construction project document management software. Retrieved from project-management.com: <https://project-management.com/top-3-construction-project-document-management-software/>
- Björk, b.-c. (2001). Document management – a key it technology for the construction industry. 1001-1009.
- Björk, b.-c. (2002). The impact of electronic document management on construction information management. Cib w78 conference. Aarhus: international council for research and innovation in building and construction, aarhus school of architecture.
- Bjork, b.-c. (2006). Electronic document management in temporary project organisations: construction industry experiences. (pp. 644-655). Emerald group publishing limited.
- Bo-christer, b. (2001). Document management - a key technology for the construction industry. Ecce (pp. 35-45). Espoo finland: association of finnish civic engineers, finland.
- Bo-christer, b. (2003). Electronic document management in construction - research issues and results. Itcon vol. 8, 105-117.
- Builderstorm. (2016, december 20). The best construction document management software. Retrieved from builderstorm: <https://www.builderstorm.com/construction-document-management-software/>
- Burcin, b. (2004). "a review on past, present and future of web based project management & collaboration tools and their adoption by the us aec industry. International journal of it in architecture engineering and construction, 233-248.
- Devanand, p. C. (2015). Importance of electronic document/information management systems. International research journal of engineering and technology, 2197-2204.
- Doccept. (2016, may 17). Why doccept document management system. Retrieved from www.doccept.com: <https://www.doccept.com/solutions/construction>

- E, I., & Mansuri. (2014). Web based construction project management. *International journal of advanced research in engineering, science and management* .
- Egan, S. J. (1998). *Rethinking construction*. London: HMSO .
- Electronic document. (2019). Retrieved from wikipedia: https://en.wikipedia.org/wiki/electronic_document
- Guo, F., Jahren, C. T., & Turkan, Y. (2015). Electronic document management systems for transportation construction industry. 5th international/11th construction specialty conference (pp. 132.1-132.8). Vancouver British Columbia: Canadian Society for Civil Engineering.
- Hjelt, M., & Björk, B.-C. (2006). Experiences of EDM usage in construction projects . *ITcon* vol. 11, 113-125.
- Holtmann, A. (2018, September 25). Best practices for construction document management. Retrieved from viewpoint: <https://blog.viewpoint.com/construction-document-management/>
- Latham, M. (1994). *Constructing the team*. London : HMSO.
- M, B., & R, A. (2001). Information technology for construction : recent work and future directions, paper presented at the CIB World Conference. CIB World Conference. Wellington, New Zealand.
- Matheu, N. F. (2005). Life cycle document management system for construction.
- Mathias, H., & Björk, B.-C. (2007). End user attitudes towards EDM use in construction project work – a case study. *American Society for Civil Engineering Journal of Computing in Civil Engineering* vol 21, 289-300.
- Nitithamyong, P., & Skibniewski, M. J. (2004). Web-based construction project management systems: how to make them successful? *Automation in Construction* , 491-506.
- O'Brien. (2000). Implementation issues in project web sites. *Journal of Management in Engineering*.
- Oxford dictionary. (n.d.). Retrieved from oxford dictionary: <https://en.oxforddictionaries.com/>
- R, H., A, K., & O, S. (1998). Surveys of IT in the construction industry and experience of the IT barometer in Scandinavia. *Electronic Journal of Information Technology in Construction (ITcon)*, 45-56.
- Roper, M., & Millar, I. (1999). *Managing electronic records*. International Council of Archives.

- Sage. (2012). The benefits of document management. Retrieved from sage construction and real estate:
<http://www.sage.com/na/~media/220f738adef54a8c882d997c1c57e395.pdf>
- Samuelson, o., & bjork, b.-c. (2010). Adoption processes for edm, edi and bim technologies in the construction industry.
- Wikipedia. (2019). Electronic document. Retrieved from wikipedia, the free encyclopedia:
https://en.wikipedia.org/wiki/electronic_document
- Wong, t. Y. (2012). Web-based document management systems. Fig working week 2012. Rome, italy.
- Y, r., & g, c. (1998). A proposed open infrastructure for construction project document sharing. *Electronic journal of information technology in construction (itcon)*, 11-24.
- Zm, d., h, l., cm, t., qp, s., & ped, l. (2000). An application of the internet-based. *Automation in construction* vol. 10, 239-246.

APPENDICES

Assessment of Electronic Document and Communication Management Systems in Construction Projects

Following questionnaire has been developed to collect important information about the current project that you are involving. This questionnaire aims at Assessment of Electronic Document and Communication Management Systems in Construction Projects. The findings of the survey will be solely used for an academic exercise where confidentiality will strictly be maintained.

* Required

Part 01

General information & background of the respondent

1. Name (Optional)

2. Organization/Company Name

3. Designation

4. Total years of service in the area of construction industry? *

Mark only one oval.

- Less than 5 years
- 5 - 10 years
- 10 - 15 years
- More than 15 years

Part 02

Information about Current project involved

5. Name of the Current Project

6. Type of project *

Mark only one oval.

- Road
- Building
- Irrigation
- Other: _____

7. Role of your organization in the project *

Mark only one oval.

- Client
- Consultant
- Main Contractor
- Sub-Contractor
- Other: _____

8. Type of the client *

Mark only one oval.

- Government
- Private - Local
- Foreign

9. Value of the project (Rs.)

Mark only one oval.

- Less than 1 billion
- Between Rs. 1 billion -5 billion
- Between Rs. 5 billion -10 billion
- More than 10 billion

10. Planned duration

Mark only one oval.

- Less than 1 Year
- Between 1 Year – 2Years
- Between 2 Years – 3 years
- More than 3 Years

11. Prime Communication Mode of the Current project (Between Client,Consultant & Contractor)

*

Mark only one oval.

- Paper based communication *Skip to question 12.*
- Web based document control software *Skip to question 20.*
- Other: _____ *Skip to question 20.*

Paper based communication User

Rate the followings on communication mode of current project

12. Reason to adopt current communication mode *

Check all that apply.

- Client influence
- Influence of the top management
- Less cost
- Less use of resources
- Other: _____

13. Security & Reliability issues of paper based communication

Mark only one oval per row.

	Very low	Low	High	Very High
Loss of document or data	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Access by not authorized person	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Legal Validity of documents	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Repetitive printing of documents	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

14. Facilities required for the paper based communication

Mark only one oval per row.

	Very low	Low	High	Very High
Need of Computer literacy	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Need of Internet & other software facilities	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Need of hardware facilities (Computer, Printer, etc)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

15. Coordination issues among different parties due to improper communication

Mark only one oval per row.

	Very low	low	High	Very High
Coordination issues between Client, Consultant & Contractor	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Coordination issues between MEP Services	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Time taken to coordinate between different parties	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

16. Difficulties to find project documents

Mark only one oval per row.

	Less than 1 minutes	Between 1-5 minutes	Between 5-10 minutes	More than 10 minutes
Average time to refer documents older less than 1 month	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Average time to refer document older 1 month to 6 month	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Average time to refer document older more than 6 months	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

17. Storage mode of documents

Check all that apply.

- File Cupboards
- Computer Hardware
- Online Database
- Other: _____

18. Reason for not to adopt web based communication system

Check all that apply.

- Not aware of web based communication systems
- Lack of funds & resources
- Lack of support by Top management
- Other: _____

19. Your past experience on Web based document control software *

Mark only one oval.

- No. I don't have *Stop filling out this form.*
- Yes. I have *Skip to question 28.*

Web based communication User

Rate the followings on communication mode of current project

20. Name of the software use currently *

21. Reason to adopt current communication mode *

Check all that apply.

- Client influence
- Influence of the top management
- Less cost
- Less use of resources
- Other: _____

22. Security & Reliability issues of web based communication

Mark only one oval per row.

	Very low	Low	High	Very High
Loss of document or data	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Access by not authorized person	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Legal Validity of documents	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Repetitive printing of documents	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

23. Facilities required for the web based communication

Mark only one oval per row.

	Very low	Low	High	Very High
Need of Computer literacy	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Need of Internet & other software facilities	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Need of hardware facilities (Computer, Printer, etc)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

24. Coordination issues among different parties due to improper communication

Mark only one oval per row.

	Very low	low	High	Very High
Coordination issues between Client, Consultant & Contractor	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Coordination issues between MEP Services	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Time taken to coordinate between different parties	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

25. Difficulties to find project documents

Mark only one oval per row.

	Less than 1 minutes	Between 1-5 minutes	Between 5-10 minutes	More than 10 minutes
Average time to refer documents older less than 1 month	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Average time to refer document older 1 month to 6 month	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Average time to refer document older more than 6 months	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

26. Storage mode of documents

Check all that apply.

- File Cupboards
- Computer Hardware
- Online Database
- Other: _____

27. Web Based Document control software previously used as a prime communication method of a project

Check all that apply.

- None
- Email
- Google Drive
- Share point
- Drop box
- Icloud
- One drive
- Asana
- Aconex
- Other: _____

Stop filling out this form.

Previously used Web based communication User

Rate the followings on communication mode previously used

28. Web Based Document control software previously used as a prime communication method of a project

Check all that apply.

- Email
- Google Drive
- Share point
- Drop box
- Icloud
- One drive
- Asana
- Aconex
- Other: _____

29. Security & Reliability issues of web based communication

Mark only one oval per row.

	Very low	Low	High	Very High
Loss of document or data	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Access by not authorized person	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Legal Validity of documents	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Repetitive printing of documents	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

30. Facilities required for the web based communication previously used

Mark only one oval per row.

	Very low	Low	High	Very High
Need of Computer literacy	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Need of Internet & other software facilities	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Need of hardware facilities (Computer, Printer, etc)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

31. Coordination issues among different parties due to improper communication

Mark only one oval per row.

	Very low	low	High	Very High
Coordination issues between Client, Consultant & Contractor	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Coordination issues between MEP Services	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Time taken to coordinate between different parties	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

32. Difficulties to find project documents in web based communication previously used

Mark only one oval per row.

	Less than 1 minutes	Between 1-5 minutes	Between 5-10 minutes	More than 10 minutes
Average time to refer documents older less than 1 month	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Average time to refer document older 1 month to 6 month	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Average time to refer document older more than 6 months	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

33. Storage mode of documents web based communication previously used *

Check all that apply.

- File Cupboards
- Computer Hardware
- Online Database
- Other: _____

