

**IDENTIFYING THE BARRIERS OF IMPLEMENTING
AN ERP SYSTEM IN CONSTRUCTION COMPANIES IN
SRI LANKA**

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Degree of Master of Business Administration in Information Technology

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The dissertation was submitted to the Department of Computer Science and Engineering of the University of Moratuwa in partial fulfillment of the requirement for the Degree of Master of Business Administration in Information Technology.

Department of Computer Science and Engineering

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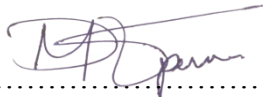
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ABSTRACT

The construction companies in Sri Lanka invest millions of rupees for both local and international ERP systems. However, the return on investment of the ERP system is not at the expected level due to implementation barriers. As a result, those companies could not get the advantage of having an ERP system such as fast communication, transparency of project progress, and reducing corruption. Further, those companies having an ERP system could not even get the competitive advantage over other construction companies.

Even though there are previous studies in other countries in a similar context, the findings of those studies may not be valid for the Sri Lankan context. There are ERP implementation barriers that are common within construction companies and barriers that are unique to a particular company which are not addressed by previous studies. Identifying those unique barriers from a quantitative study is difficult. Therefore, this study has been carried out as a qualitative study by conducting one-to-one semi-structured interviews with sixteen industry experts with middle management, including ERP project managers, construction project managers, and quantity surveyors. Those interviewees have been selected according to 'theoretical sampling', one of the purposive sampling techniques. As a result, the participants' real feelings, and experience towards the ERP and ERP implementation.

Data collection and the analysis were parallel activities. The analysis has been done according to the 'Grounded Theory'. At the end of the analysis, there were forty implementation barriers identified and out of them, 'employees' reluctance to change', 'bugs in ERP systems', and 'poor internet speed in remote sites' are highlighted by majority participants. Additionally, the recommendations have been suggested for the identified implementation barriers, which were pointed out by a number of interviewees. Further, those forty barriers were divided into six major themes as 'barriers related to management', 'barriers related to employees', 'barriers related to ERP systems', 'barriers related to implementation process', 'barriers related to vendors', and 'barriers related to organizations'.

These identified ERP implementation barriers and the recommendations would be important for a construction company that currently initiates ERP implementation in their company and the companies that plan to implement an ERP system in the near future. Further, the recommendations suggested for the ERP vendors are also important to those software development companies in order to achieve a competitive advantage.

Keywords: Enterprise Resource Planning System, Construction Companies in Sri Lanka, Implementation Barriers

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LIST OF ABBREVIATIONS

BPR	– Business Process Reengineering
CRM	– Customer Relationship Management
CIDA	– Construction Industry Development Authority
DEA	– Data Envelopment Analysis
DMC	– Decision Making Committee
ERP	– Enterprise Resources Planning
GUI	– Graphical User Interface
HRM	– Human Resources Management
ICT	– Information and Communication Technology
ICTAD	– Institute for Construction Training And Development
IT	– Information Technology
LAN	– Local Area Network
MIS	–Management Information System
MRP	– Material Requirement Planning
PC	– Personal Computer
PPT	– People Process Technology
QA	– Quality Assurance
ROI	– Return on Investment
SAP	–Systems Applications and Products
SME	– Small to Medium Enterprises
SRS	– Software Requirement Specification
VPN	– Virtual Private Network

1. INTRODUCTION

1.1. Background

With the emergence of business software applications, companies use software applications within a single business unit to gather, store, and process data without a proper communication between each functional area. Later in the 1960s, manufacturing companies started using inventory control systems and material requirement planning (MRP) systems to manage their stock levels against finished goods. With the evolution of MRP systems and application software integration, Enterprise Resources Planning (ERP) systems have emerged in the mid-1990s by addressing all major enterprises functions across the companies, including both back-office functions and front-office functions such as accounting, human resources management (HRM), and customer relationship management (CRM).

Due to the success of using ERP systems within manufacturing and service sector companies, construction companies also started using those systems for automating daily operations and improving internal communication. However, because the operations of construction companies are different from other industries, developing a unique ERP system for construction enterprises is an essential requirement (Chaudhari and Jain, 2019). For example, during a construction project there are hundreds of alterations carried out for the initial scope of work, such as finding substitute material, and escalating the size of parking slots.

Implementing an ERP system is a turning point for any organization. It is similarly applicable for construction companies. As mentioned by Çınar and Ozorhon (2018), the competition in the construction sector is also continuously increasing daily, and hence the market conditions are forcing the companies to manage their projects more effectively and efficiently while keeping the expenses at a minimal level. Many factors affect the success of the ERP implementation in such a company.

Further, Çınar and Ozorhon (2018) mentioned that the quantity and the time sensitiveness of the information in the construction field make it difficult to control the daily operations. As a result, the ERP systems developed for construction companies should have a group of unique characteristics diverse from other

industries. Therefore, customization is needed in order to respond to those specific characteristics. If not, ERP adoption in construction companies would end up integrating only the finance management related processes (Chaudhari & Jain, 2019).

Sri Lankan construction companies are spending on different ERP systems; however, whether these companies receive the real benefit from ERP system implementation remains a problem. Since Sri Lanka is a third world country, in which English is not the first language, Sri Lankan construction companies face a different set of challenges than the companies in other countries, during and after the ERP implementation process. Therefore, ERP vendors in Sri Lanka must develop a customized set of strategies when implementing an ERP system in a construction company.

1.2. Motivation

Over time, the construction sector has changed to an information-sensitive industry rather than just constructing buildings and roads. Due to the value and the requirement of timely communication of information, over geographical boundaries, construction companies could not survive without digitizing and integrating latest Information and Communication Technology (ICT) innovations. Several Sri Lankan construction companies that realized the benefits of ERP systems have also invested ERP systems in their organizations.

However, the majority of those companies have not implemented a fully automated ERP system. Some construction companies such as ‘Maga Neguma’, and Sierra Road Engineering, have already stopped using the ERP system entirely and others are using the system only for one or several modules. Çınar and Ozorhon (2018) refer to the ideas of Chen (2001) that 40% of ERP implementations ended up with partial implementation and 20% of ERP implementation efforts become total failures in construction companies in Turkey. Therefore, it is possible to argue that there is a considerable failure rate in implementing ERP systems in construction companies and those stories also can be considered for identifying the success factors of ERP implementation.

The literature before 2005 also discusses the challenges of ERP implementation in the construction field, and they also provide many suggestions to overcome those challenges (Shi & Halpin, 2003). Gavali and Halder (2019) mentioned that even after spending huge amounts of effort, money, and time the failure rate of ERP implementation in the construction industry is comparatively higher than the other industries. It shows that still many construction companies struggle to implement an ERP system.

Further, with the popularity of the open-source paradigm, free and open-source ERP systems such as 'ERPNext', and 'EazyERP' have also been developed worldwide with a greater extent of customizability. Additionally, mobile devices with internet access such as smartphones, tabs also got popular during the last decade, and therefore, those open source ERP systems could be accessed via mobile devices. The cost of such an open source ERP system is lower than the famous proprietary ERP systems such as 'SAP', and 'Oracle ERP'. However, construction companies hesitate to adopt an ERP system and automate their processes to enable fast communication among their stakeholders (Çınar & Ozorhon, 2018).

The failure of ERP system implementation in construction companies could be due to one or more reasons. Chan and Sin (2010) have identified five major reasons as 'customizing ability of the ERP system', 'level of user training', 'need of business process re-engineering', 'level of price', and 'availability of vendor's helpdesk', that are negatively affect to the ERP implementation in Chinese construction companies. Ali (2017) also has recognized six factors as 'lack of requirement analysis', 'not analyzing the available resources', 'lack of change management plan', 'not identifying business processes in early stages', 'not identifying proper software development strategy', 'implementation team is not representing all departments' that disrupt successful ERP implementation in construction companies in Saudi Arabia. Further, 'employees' reluctance', 'lack of scope management', and 'geographical distribution' have been considered as the main limitations for implementing an ERP system within construction companies in Turkey (Çınar & Ozorhon, 2018).

Therefore, it is necessary and essential to identify the actual reasons as to why construction companies in Sri Lanka hesitate to implement ERP systems within their organizations. It will support these organizations to be motivated and convinced for implementing ERP systems and enjoying all the benefits of having an automated, paperless office environment.

1.3. Research Scope

Even though Sri Lankan construction companies invest both time and money in ERP systems, they have not taken the real output from those systems. Therefore, this study has been primarily focused on recognizing the barriers and challenges of implementing an ERP system in construction companies within the context of Sri Lanka. For this study, only the C1, C2, and C3 companies graded by the construction industry development authority (CIDA) have been taken into consideration. Because the difference among those companies in terms of company size, number of skillful employees, their experience in the industry, construction projects success rate, and so on is minimal. The number of companies within each company grade is listed in Table 1.1. Reginold and Dickkuburage (2009) also considered only the companies in C1, C2, and C3 grades to carry out their study on identifying barriers of ICT implementations in relation to the building construction sector in Sri Lanka.

Table 1.1: Number of Construction Companies in Each Grade

Company Grade	Number of Companies
C1	62
C2	85
C3	139
Total	286

Source: https://www.cida.gov.lk/sea_con/search_gradesnew.php (2021)

Further, the construction companies that fully implemented an ERP system, the companies that use an ERP system only in several functional areas, and the companies that discontinued using an ERP system are considered for this study. However, it is noted that some companies have different unique application software in different departments and do not share any information between those individual

software. Such companies also have not counted as companies with ERP systems. The study was done within nine months starting from July 2020 to March 2021.

1.4. Statement of the Problem

The construction industry carries out its operations project wise in Sri Lanka. Therefore, both intra-project and inter-project communication is essential for achieving the company goals and objectives. Furthermore, easy access to the updated information is also essential for the success of construction projects. The status updates and real-time information help managers make the right decision at the right time. ERP systems help companies maintain smooth, uninterrupted, and speedy information flow in both upward and downward sides of the supply chain.

However, most Sri Lankan companies could not take these benefits with the support of an ERP system. Even though some large companies try to implement an ERP system by spending both money and time, they could not implement the system for all functional areas. Some companies have failed to implement an ERP system and moved back to the traditional paper-based procedures that are ineffective and impossible to prevent corruption. Therefore, this study aims to identify the reasons towards the successful ERP implementation for Sri Lankan construction companies. Hence, this study addresses the research question “**What are the reasons that make the ERP implementation difficult in construction companies in Sri Lanka?**”

1.5. Research Objectives

Following research objectives were developed for finding solutions for the identified research problem. Based on the approach followed by Chan and Sin (2010) in their study, the user perception on information systems has been divided into four quality variables and therefore, the second objective has four sub-objectives.

1. To identify the implementing process of an ERP system in Sri Lankan construction companies
2. To capture management perception and observation of using or implementing an ERP system in their construction companies
 - 2.1 To capture management perception and observation on system quality variables of ERP system in their company

- 2.2 To capture management perception and observation on information quality variables of ERP system in their company.
- 2.3 To capture management perception and observation on service quality variables of ERP system in their company.
- 2.4 To capture management perception and observation on organization related variables of ERP system in their company.
- 3. To categorize those perceptions as positive or negative factors for implementing an ERP system.
- 4. To identify the common negative factors for the ERP system implementation and provide recommendations.

1.6. Research Significance

Number of studies has been carried out regarding ERP systems implementation in different industries, especially in manufacturing companies. There are several research studies done for construction companies also. However, only a few studies have been done in order to find the behavior of ERP systems in a construction company. For example, Chan and Sin (2010) have carried out a study to find success factors of implementing an ERP system by analyzing how the ERP system quality factors affect the user satisfaction in construction companies in China.

Further, several studies have been carried out to find the role of ERP systems within Sri Lankan construction companies. Among those studies, Hewavitharana and Perera (2019) have researched the gap between construction business processes and ERP features. Even though there is literature on construction industry specific ERP systems, most of such literature did not focus on ERP implementation difficulties. Therefore, identifying the factors that negatively affect the ERP implementation is essential, and throughout this study, the behavior of ERP implementation barriers and critical success factors that have been identified in other countries are analyzed in relation to Sri Lankan construction companies.

1.7. Chapter Outline

- Chapter 1: Introduction

The details related to the background of this study have been discussed in this chapter. The research problem and the objectives are also discussed in detail in this chapter.

- Chapter 2: Literature Review

This chapter provides a detailed summary of previous research done related to ERP implementation in construction companies. Those works of literature have been discussed under four sub-topics in this chapter.

- Chapter 3: Research Methodology

Within this chapter, research methods adopted to achieve the research objectives are discussed. The data collection mechanisms and the data analysis techniques are also described in this chapter.

- Chapter 4: Data Collection and Analysis

The data gathered from the interviews are summarized, and a detailed analysis is conducted to identify the findings of this study in this chapter.

- Chapter 5: Conclusion and Recommendations

Final outputs of the study have been included in this chapter, and the recommendations have been given for the identified barriers of implementing an ERP system in a construction company in Sri Lanka.

2. LITERATURE REVIEW

There are different aspects of implementing an ERP system, and the researchers have discussed different methods of implementing the ERP system in many industries and many countries. Therefore, the identified literature sources have been categorized under four sub topics and relevant points are discussed in this chapter. The sub categories are:

- a. ERP Implementation Process in Construction Companies
- b. ERP Implementation in Sri Lankan Construction Companies
- c. Barriers and Challenges of ERP Implementation in Construction Industry
- d. Critical Success Factors of ERP implementation in Construction Companies

2.1. ERP Implementation Process in Construction Companies

There are several literature regarding ERP implementation in construction companies, especially in Saudi Arabia. Hadid, Assaf and Alkhiami (2017) proposed a systematic approach with four steps for implementing ERP modules in a construction company since there is a high risk of failing the ERP implementation in the construction industry if it is not done in a systematic approach. According to the analysis of this study, ERP systems can be easily and successfully deployed in manufacturing and trading firms.

In contrast, the study by Hadid, Assaf and Alkhiami (2017) mentioned that a higher failure rate is reported in the construction field due to the complex business environment and unique features of each project/client. Defining the most common ERP modules, defining the expected benefits of ERP implementation, defining the critical index and ranking the ERP modules according to the overall index are the four steps that suggested to be followed for a successful ERP implementation. Additionally, it involves re-engineering the company work process, staff training, and upgrading the IT infrastructure.

Thirteen ERP modules were discussed in the above research under six benefit criteria such as user satisfaction, information quality, and cost reduction. Those modules were ranked based on scoring inputs of the respondents from seven largest

construction companies in the Eastern province in Saudi Arabia. Out of those thirteen modules, inventory control and logistics, procurement, project financing and accounting, and project management and budgeting are the top four modules ranked according to the score given by the respondents.

Problems of estimating the customization level at the initial stages of ERP implementation have been addressed by Parthasarathy and Daneva, 2016. This study would help decision-makers when approving requests for customizations. The primary objective of the above research was to guide the ERP customization process in the right direction by taking cost and the value of each option into consideration. Therefore, an approach that customization requirements are determined in a quantitative algorithm has been suggested to solve those problems. In their approach, ‘client-prioritized requirements’ have been used to estimate the degree of customization while considering the cost and value associated with each customization option.

The summarized steps of the analysis conducted by Parthasarathy and Daneva (2016) are presented in Figure 2.1. First, the client requirements of each ERP are prioritized depending on a framework that is based on cost-benefit analysis and those requirements are classified under three levels as design requirements, application requirements, and process requirements. After that, an algorithm has been developed, which was introduced by the authors, named as “prioritized requirements based customization estimation algorithm”. Finally, that algorithm traces the gap between customers’ prioritized requirements and the features that are embedded in the ERP software.

According to their findings, the algorithm developed by Parthasarathy and Daneva (2016) can be practically applied when estimating the customization level of ERPs in the initial project stages of the ERP implementation, such as gap analysis, business process analysis, and project scoping that carry out by both client representatives and representatives of ERP implementation team. ERP project managers and program managers are the primary users of that algorithm, who are responsible for presenting alternative ERPs with different scopes to the senior managers. One of the main

advantages of this algorithm is that it helps eliminate the human judgment-based approaches, which are different from person to person, affecting the gap between organizational business requirements and the functionalities provided by the ERP software package.

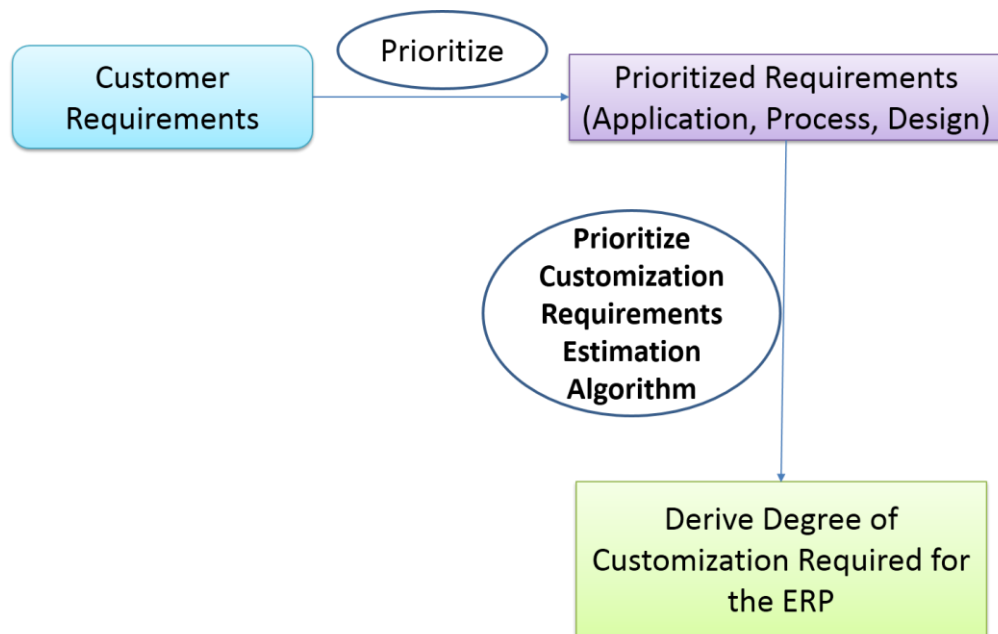


Figure 2.1: Steps of the study done by Parthasarathy and Daneva (2016)

In addition, these authors stated that their solution is a feasible and cost effective solution for keeping the ERP customizations aligned with the company's business goals and objectives. Finally, a real-life case study of a mid-sized client organization in India has been taken for validating the application of the proposed frameworks and algorithms.

The stakeholders of that organization could see the quantitative information that help them to decide on the ERP customization effort or reengineering effort of the organization processes to fit with the ERP. Further, the authors believe that quantitative information would be beneficial for the requirements of negotiations with the ERP vendors. The strengths and weaknesses of this approach have also been discussed, along with its implications for research and practice.

Finally, Parthasarathy and Daneva (2016) mentioned that their estimation algorithm could be used in a client organization to compare multiple ERP packages against

their requirements on selecting the most appropriate ERP system. However, they did not recommend their approach for the open source ERP systems, which have no proper documentation. Because in an open source system, documenting the functionalities of the system would be a task of the client company and the time and cost involving those tasks are not covered by the algorithm proposed by the authors. Further, this research suggested that more attention is required for analyzing the relationship between ERP software customization and decision making processes for approving ERP projects in an organization.

Selecting the most appropriate ERP system out of several other alternative systems for an organization is a challenging task for the decision makers (Mohammad, Khaled, Ahmad, & Shaher, 2015). This evaluation process becomes further complicated when decision-makers have to consider several different attributes that are not congruent in terms of a unit of measures, such as monetary sum, time, and subjective score. As a solution for the above problems, Mohammad et al. (2015) have proposed a multi-attribute decision-making model based on Data Envelopment Analysis (DEA).

The decision-making process of the proposed DEA model by Mohammad et al., 2015 has five major stages for selecting an ERP. The construction company should formulate an ERP Decision Making Committee (ERP-DMC) at the first step. The committee should contain managers and responsible personnel from each department of the construction company. During the second stage, it is expected to collect data of each potential ERP system, including their characteristics and suppliers in the market by the formulated ERP-DMC. Wei and Wang's (2004) study (as cited in Mohammad et al., 2015) suggested considering the reports issued by professional organizations, research institutions, and consulting firms for the data collection since those institutions have experts who evaluate data regarding ERP systems in the point of market share, vendor size, and system performance.

In stage three, the committee identifies the required ERP attributes and the method of measuring for the construction company. The required attributes have been divided primarily into two categories as software factors and vendor factors. Customization

capability, compatibility with old systems, and the capability to offer information on time are some of the important software factors. Examples of vendor factors are implementation and service ability, construction domain knowledge, and consulting service.

The proposed DEA model is applied in the stage four. The authors mentioned that DEA is based on an input-output framework and the model derives maximized outputs while minimizing inputs. Both inputs and outputs should be in numerical format. When evaluating different ERP systems, the ability to incorporate multiple distinct attributes, is one of the strengths of the DEA model, even though those attributes are not in the same measurement unit. Finally, in stage five, ERP-DMC concludes the decision making process by selecting the optimal ERP system from the analyzed systems based on the results in stage four.

This five-stage model is validated through a highest class Jordanian construction contractor to select the best suited ERP system out of eleven alternative systems. Six attributes namely, Customization Capability, Total Cost, Implementation Schedule, Functionality, User Friendliness, and Service and Support Quality have been considered in the evaluation process. Then, a sensitivity analysis has also been conducted in order to prove the stability and robustness of the proposed DEA model. In addition to the sensitivity analysis, industry feedback also has been taken using a survey questionnaire by the authors. Nine top and middle managers who were engaged in ERP system selections, have participated in the evaluation. They have rated the proposed model positively related to model structure, implementation stages, performance results, and overall usefulness.

With the main objective of investigating how ERP will impact the construction industry, Hewavitharana, Nanayakkara, Perera, and Perera (2019) have conducted a study as adopting an ERP system in construction companies is far behind than other industrial fields. Since the construction industry is a highly heterogeneous and unique sector, the authors mention that it needs specialized ERP systems and vendors. Moreover, previous researchers only concentrate on how ERP systems affect the process of a construction company, and they have not focused on the

financial performance of construction companies with the implementation of an ERP system. Therefore, they have analyzed 210 financial statements from 29 large and medium construction companies in developing and developed countries. The variables such as revenue, expenditure, operating cost, material cost, and inventory have been considered before and after implementing an ERP system in those construction companies.

As indicated in Figure 2.2, results proved that 90% of the construction companies that have implemented an ERP system achieved a growth or survival with their construction activities. Only 3% of the total considered companies has successfully managed the construction activities without using an ERP system. Further, the authors have revealed that for a successful ERP implementation, organizations need to fulfill more than 10% in both ERP readiness ratios named investment/revenue and intangible assets/fixed assets. Additionally, they have mentioned that the training budget allocated by the construction companies for ERP systems is much lower than the requirement.

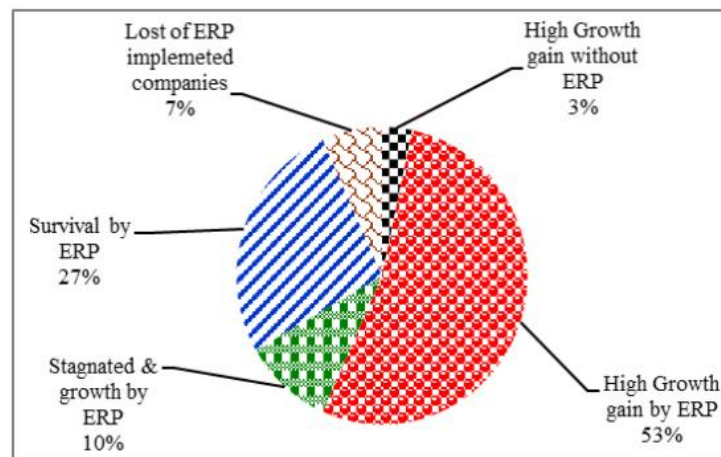


Figure 2.2: Impact of ERP Implementation on Company Growth
Source: Hewavitharana et al. (2019)

Further, Hewavitharana et al. (2019) mentioned (as cited in Nanayakkara, Perera, & Perera, 2013) that since construction companies have unique functionalities, it needs a specialized ERP and ERP vendors in order to implement a successful system. Further, they have identified that not having clear objectives of using an ERP before implementation, lack of senior management involvement, and incompatibility of

software with the company objectives are some of the barriers to implement an ERP system for a construction company.

In addition to those direct factors, some indirect barriers have also been listed as management styles, labor skills, and government regulations. However, Hewavitharana et al. (2019) have listed some of the benefits of having an ERP system in a construction company (as cited in Seo, 2013) such as increasing managerial flexibility and improving the communication beyond the functional boundaries, and shortening the lead time.

Through the data analysis, Hewavitharana et al. (2019) have found that the impact of ERP implementation depends on the company size. The results of their analysis indicate that, 62% of the large companies have gained a higher growth rate while only 41% of medium-sized companies acquired a higher growth rate after implementing an ERP system. Furthermore, it is mentioned that all the companies that have implemented an ERP system successfully, have invested more than 10% of their total investments on intangible assets. Therefore, the authors mention that if a construction company could not invest 10% of the revenue for the intangible assets, that particular company is not ready to implement an ERP system.

2.2. ERP Implementation in Sri Lankan Companies

Hewavitharana and Perera (2019) have mentioned that even though an ERP system delivers a lot of benefits to construction companies, those companies hesitate to adopt an ERP system for monitoring and controlling their daily operations. Therefore, they evaluated the gap between construction procedures and ERP procedures in Sri Lankan construction companies. Their findings reveal that there is a substantial difference between the business processes followed by those companies and the business processes defined in major ERP systems. Some companies are having ERP systems with the capabilities of customizing the system for matching the company business processes, and as a result, such companies do not want to change their business processes. However, those customizations are costly and risky (Hewavitharana & Perera, 2019).

As the final outcome of the analysis, Hewavitharana and Perera (2019) sorted the ERP system modules according to the statistically calculated gap (Chi-Square value) between construction procedures and the ERP procedures. Inventory management related functions have the highest gap, and human resources management related functions have the second-highest gap between ERP business process and the actual business process. Comparatively, the sub-contractor management module has the lowest gap, and the estimating and tendering module has the second-lowest gap. Based on these gaps, a framework has been developed to meet organizational processes and ERP processes.

Hewavitharana, Perera and Nanayakkara, (2019) have also conducted a study for identifying the correlation between four basic dimensions named ‘product’, ‘people’, ‘project’, and ‘business process’ when implementing an ERP system in small to medium-sized enterprises (SME) in Sri Lanka. The authors have identified that large companies have already installed an ERP system, and comparatively SMEs are still struggling to implement an ERP system in Sri Lanka. However, due to the market saturation of large companies, the ERP vendors are now targeting SMEs (Hewavitharana, Perera, & Nanayakkara, 2019).

Table 2.1: Correlation between Basic Parameters in SMEs Sri Lanka

	Product D	PeopleF	ProjectD	BusP
ProductD	1.000	0.574	0.553	0.385
PeopleF	0.574	1.000	0.587	0.516
ProjectD	0.553	0.587	1.000	0.360
BusinessP	0.385	0.516	0.360	1.000

Source: Hewavitharana, Perera, and Nanayakkara (2019)

A questionnaire survey and semi-structured interviews with ERP vendors, ERP consultants, experts, users and employers have been carried to collect the data for their study. The result of correlation analysis has indicated a strong positive interrelationship between each of the four basic dimensions, as mentioned in table 2.1. The maximum correlation exists among ‘project’ and ‘people’ dimensions with the value of 0.587. The second highest correlation of 0.74 is indicated between

‘people’ and ‘product’, and the third-highest correlation is generated between both ‘project’ and ‘product’, having the value of 0.553 (Hewavitharana & et al., 2019).

Therefore, the authors suggest SMEs need to consider their capacity to accomplish the above necessities before implementing an ERP system. After further analysis, Hewavitharana et al. (2019) have mentioned that open source ERP systems are not suitable for large companies with large business operations. However, open-source ERP systems are more compatible for SMEs since those systems require low proprietary technologies, and do not need licenses for third-party software such as operating systems and databases. Finally, the authors recommend establishing standards for both ERP systems and business processes for a successful ERP implementation (Hewavitharana & et al., 2019).

2.3. Challenges of ERP Implementation in Construction Industry

Çınar and Ozorhon (2018) have conducted a study to explore the ERP implementation process in construction firms while identifying the challenges and key enablers as failure rates are high in the construction industry. However, the authors have identified that construction companies that implemented an ERP system have gained a lot of benefits such as fast and easy generation of operational management reports for each construction site and faster access of correct and current data from the construction sites at different geographical locations. Additionally, they have identified that some business processes are revised, simplified, enhanced, and reengineered with the implementation of a new ERP system.

In order to identify ERP implementation challenges and enablers, Çınar and Ozorhon (2018) have carried out questionnaire surveys and face-to-face interviews with team leaders of ERP implementation projects in three large construction companies in Turkey. These three cases have been used to compare the company’s ERP implementation challenges, strategies and decisions to obtain a successful ERP system. The selected team leaders have a total duration of experience between 11 to 15 years.

The interview questions have covered areas such as ‘why companies decided to implement an ERP’, ‘what types of resources were utilized’, and ‘what are the benefits they received from the ERP’. According to the responses, the major reasons for implementing an ERP system in those three companies are accessing the same business data, reporting right and current information about businesses, creating spontaneous management reports, and integrating different construction sites with headquarters. Further, Çınar and Ozorhon (2018) stated that various resources, in terms of 'human' and 'financial' have been utilized to implement the ERP system in all the three companies that they considered for their study. Extra funds allocated for employee training programs, hiring experienced consultants, and paying for the key implementers are some of those resources.

The three most significant challenges that these authors identified are the reluctance of the employees, lack of scope management, and geographical barriers. Further, they described that lack of knowledge of the ERP systems and resistance to change are the main reasons for employee’s reluctance. In addition to those reasons, the employees had to engage with new tasks apart from their daily responsibilities, which required more time and effort, and therefore, it also negatively impacted most employees. As a result, those employees resist accepting the new system. The authors highlight that it is necessary to keep system errors and mistakes at a minimal level during the ERP implementation since employee’s impatience with those system errors and mistakes could lead to rejection of the system.

The interviewees emphasized that lack of an ERP strategy at the implementation is a weakness of the scope management, and it is critical and essential to have clear definitions on goals and objectives about what is expected from the ERP system by the top management. By describing the geographical barriers, Çınar and Ozorhon (2018) have mentioned that construction companies that are operating in different locations within a country or in different regions of the world encounter many challenges, such as internet connection problems, and difficulties in training the employees at far away sites. Therefore, international contractors who are doing business abroad should plan their ERP implementation even more carefully.

The authors listed six critical enablers as business process re-engineering (BPR), management support, skillful implementation team and a leader, training, clear goals and objectives, and consultancy that help overcome the above challenges. During this study, all interviewees have mentioned that demonstrating the outcomes and benefits of the ERP system to the employees and the implementation team by top management executives is essential since it improves their motivation significantly. With the ERP implementation, some critical revisions can happen in the organization and in the business workflows. Therefore, Çınar and Ozorhon (2018) say that having BPR operations for managing the organizational changes before ERP implementation is beneficial for the long run of the ERP system.

In addition, authors mentioned that the top management should have a clear idea of what to expect from the ERP implementation. In order to achieve that, the implementation team should be equipped with a proper implementation strategy with clear goals and objectives because it would help to plan and decide which modules and features should be included in the system to get the maximum benefit from the ERP. Choosing the best-fit software package, ERP features, and ERP modules have been identified as critical success factors of ERP implementation. In addition to having the right and best implementation team, having an effective and experienced team leader is a key enabler for the planning process and motivating the team.

As mentioned by Çınar and Ozorhon (2018), regular training and support for the end-users is an essential factor for a successful ERP implementation because it helps remove knowledge barriers and overcome the reluctance of employees (end users). Further as described by the interviewees, the consultant's involvement and vendor support also play a major role in the success of ERP implementation. Moreover, obtaining relevant information about old procedures from the end-users by the consultants positively helps for the system implementation. Therefore, choosing the right consultant is a key enabler during the ERP implementation process.

As a conclusion, Çınar and Ozorhon (2018) stated that based on the three companies they considered, the most important lesson learnt is that the 'human' factor is the most critical component during the ERP implementation process. Even though

developing an advanced computer system, the main attention should be paid not only to the ‘technology’ factor but to humans, end-users of the system, members of the implementation team, and the consultants also.

Ali (2017) mentioned that implementing off-the-shelf ERP systems, which are developed on best business practices, is a challenge for construction companies compared to the manufacturing and service industries, because of the difficulty of satisfying a unique set of organizational needs. According to this author, each construction project has its unique characteristics in terms of design, resources, and operational requirements even within a single company. Additionally, such projects are distributed in different geographical areas, and multiple teams are working simultaneously.

Therefore, if an off-the-shelf ERP system is selected, the company needs to restructure business processes to match with the features of that particular ERP system. Otherwise, it may create conflicts within the company and finally end up with productivity losses or implementation failures. If the company tries to implement an ERP system without a “realignment strategy”, the technical and administrative challenges would occur, causing project delays or complete implementation failures.

The author also added that since there are customizable ERP systems available, instead of restructuring the business processes according to the ERP system, the company is capable of customizing the ERP system to suit their business processes. However, customization could be a long, complex, and costly process with the probability of failure, which also requires detailed planning and thorough attention. During this study, an in-house ERP system was implemented in a construction company based in a developing country. The author explored the challenges that the development team and implantation team faced. In order to collect relevant data, a series of interviews and discussions have been carried out with the project manager, development staff, and the end-users.

Ali (2017) has further noticed that the employees’ fear of change and the unwillingness to share information are the main challenges during the ERP

implementation stage. It was mainly because the employees had uncertainty of incoming transformation and the impact on their job roles and job security. Those challenges had been overcome by involving the employees during the ERP implementation planning stages and convincing them of the benefit of having such a new system for the company. In conclusion, Ali (2017) stated that to have a successful ERP implementation in a construction company, complex software customization or changing the business processes should be eliminated or minimized. Comparatively, an in-house developed ERP system would significantly decrease the probability of ERP implementation failure while letting the company emphasize more on its core business functionalities.

2.4. Success Factors of ERP implementation in Construction Companies

To identify the causes that are critical for ERP systems implementation in Chinese construction companies, Chan and Sin (2010) have conducted a questionnaire survey among contractors in Guangdong province of China and Hong Kong. The authors mentioned that construction business processes are more fragmented and complicated than manufacturing business processes due to factors such as non-standard production processes, distant locations of the project members in different geographical areas, and on-going order changes. As a result, construction companies have dealt with inefficient communication, cost/time overrun, and unexpected material wastage (Chan & Sin, 2010).

Chan and Sin (2010) have finalized 25 factors that support a successful ERP implementation using focus group discussions. These authors divided those factors into three categories as system quality variables, service quality variables, and information quality variables. The factors that reflect the quality of the ERP vendor or the IT department who provides the technical assistance have been categorized under service quality variables. Under the information quality variables, all the factors related to system outputs are categorized, and the features of the ERP system which help the successful implementation are grouped as system quality variables. Twenty six (26) construction companies were selected for the questionnaire survey, and 178 questionnaires were distributed among those companies to carry out the data collection. Using the survey results, the authors have observed the correlation

between each quality variable and the user satisfaction level (Chan & Sin, 2010). The authors have derived five variables that strongly create an impact on successful ERP selection and implementation out of 25 factors. Those factors are customization capability, amount of user training, price of the ERP system, helpdesk service level provided by the system vendor/IT department, and the level of the BPR.

The service level provided by the system vendors' helpdesk is one of the factors that has not been strongly discussed in the previous literature. Chan and Sin (2010) mentioned that discovering system bugs, faults, or configuration issues are expected during the early stages of system implementation. If the system users do not receive the immediate support from system vendors or the IT department, it would result in user frustration and work interruption, and negatively affects their willingness to use the system. In the questionnaire of Chan and Sin (2010), the respondents have mentioned that most of the ERP system vendors' help desks' regular response speed is very low. Since ERP is a complex system and affects all the departments of the company, the authors suggest that having a formal contract with the ERP supplier regarding the support level and the response time of the helpdesk will help for successful ERP implementation. Furthermore, such a contract could be used as a parameter during the ERP selection process (Chan & Sin, 2010).

Due to employee resistance, BPR is a challenge for an organization. However, naturally, ERP is used as a tool for BPR in a company. Therefore, Chan and Sin (2010) recommend taking vigilant measures to guarantee that the ERP system is suitable for the company objectives. Otherwise, employees may feel that 'reengineering took place due to the ERP implementation', resulting in refusing the use of the ERP system. Additionally, Chan and Sin (2010) have mentioned that construction companies consider price and maintenance cost of the ERP system as the most critical factors when selecting the ERP system. Hence, that is a good indication for the international ERP service providers willing to spread their market share within China.

The managers, who responded to the questionnaire conducted by Chan and Sin (2010), have mentioned that their subordinates do not have experience and

knowledge of ERP systems. Therefore, providing sufficient training to all the ERP users is essential in the early stages of the ERP implementation, and the authors suggested designing differentiated training programs for each department. For improving the effectiveness of the training sessions, taking feedback during the user training is also recommended by the authors. Since different organizations follow different management styles and business processes, ERP operations should also be customized accordingly. As Chan and Sin (2010) mentioned, the respondents stated that even though the ERP suppliers promise to customize the ERP system according to the company's unique requirements, the level of customization is not adequate for continuing the business. As a result, managers face several problems during the ERP implementation even with leading ERP suppliers. Therefore, Chan and Sin (2010) suggested studying the features of the ERP package thoroughly and carefully checking whether those features match the organization's business processes during the ERP selection stage. However, the companies with a tailored, in-house developed ERP system had not encountered such negative experiences and it also helped minimizing the risk of implementation failure (Chan & Sin, 2010).

Moreover, the outcome of the questionnaire survey done by Chan and Sin (2010) shows a noticeable relationship between user satisfaction and the ERP systems that support multiple languages. Even though Chinese people consider multiple language support as the most important success factor out of 25 factors of successful ERP implementation, the authors argue that this factor may be insignificant for the people who commonly use English for their communication (Chan & Sin, 2010). Other than the language factor, some managers have mentioned that organizational background and culture also need to be considered for selecting an ERP system.

However, the small sample size taken for the study done by Chan and Sin (2010) is a limitation of their study. Further, this study had been carried out only within the Guangdong area in China. Further studies are recommended considering the whole country with larger sample size and a large number of factors because the outcomes of this study are useful for both ERP suppliers and Chinese construction companies that design their own ERP system or select a proper ERP system.

Cinar and Ozorhon (2015) have identified 14 critical success factors of ERP implementation from previous literature. These authors have conducted a questionnaire survey to analyze the behavior of those 14 success factors in construction companies in developing countries, and quantified the influence of those 14 factors on ERP implementation success. Data for the statistical analysis has been collected from 90 construction companies in Turkey. At the end of the statistical analysis, those 14 critical success factors have been divided into three main categories: human factors, organizational factors, and technological factors.

For the factor analysis, two tests were carried out, namely Barlett's test of sphericity and the Kaiser-Meyer-Olkin adequacy test. According to the calculations, 4% of the construction companies stopped using the ERP system due to the implementation failure. However, the final result of their analysis shows that clear goals and objectives, top management support, project leader's effectiveness, and team members' cooperation are the most critical factors that affect the ERP implementation success. Comparatively, vendor support, software choice, system testing, and use of consultants are the factors that have a lesser impact on ERP implementation success (Cinar & Ozorhon, 2015).

Since skillful project managers have the ability to resolve any kind of problem, Cinar and Ozorhon (2015) argue that the effectiveness of project managers has been considered as the most important factor in the human category. Mainly, the project leaders have to resolve the conflicts and communication issues between departments and people. Furthermore, the authors have mentioned that the top management should identify the requirement of proper system training for the end-users and provide enough funds for conducting supportive training sessions (Cinar & Ozorhon, 2015).

Additionally, Cinar and Ozorhon (2015) stated that the implementation team has to identify and understand the actual requirements of end-users as early as possible. Because, it would help developing a proper system with the functions as required by the end-users and it will increase their satisfaction and easiness of training with the system. The organizational culture would also be changed with the implementation

of an ERP system. However, according to the study of Cinar and Ozorhon (2015), changing the staff mindset and the organizational culture is not an easy task within construction companies. Therefore, the authors argue that organizational change management is also a significant human factor for a successful ERP implementation.

Cinar and Ozorhon (2015) concluded their findings, mentioning that ‘human’ factors have a higher impact on successful ERP implementation success than the ‘organizational’ factors and the ‘technological’ factors. Because, even though ‘technology’ is the basis of any ERP system, without the help of ‘human’ and ‘organization’ factors, the ERP implementation will not achieve success.

Gavali and Halder (2019) conducted a study to find critical success factors for implementing an ERP system in construction companies based on descriptive literature analysis. Identified factors have been analyzed from a frequency analysis, and the success factors described in several previous studies have been included as more important factors. According to the ranking, the top five critical success factors are ‘software management’, ‘legacy system knowledge’, ‘top management support’, ‘implementation team composition’, and ‘business vision’.

Gavali and Halder (2019) also described that employee resistance could be reduced with the top management commitment and support. Finally, this study mentions that the construction industry will be improved with comprehensive ERP systems and cloud computing in the future. Chaudhari and Jain (2019) conducted a study to identify the influences for the success or failure of ERP systems completion in the construction industry, and they developed a model to evaluate those influences with other successful ERP systems. That model helps senior managers make better decisions when selecting the most suitable ERP system for their company out of several potential ERP systems. A questionnaire survey has been carried out to investigate the ERP implementation status and measure the influence of different factors of ERP system implementation success.

According to the questionnaire results, more than 50% of respondents mentioned that an ERP system could be successfully implemented in their company and that system would be beneficial to the company. However, a considerable number of respondents

also stated that an ERP system would not work successfully due to lack of resources and limited technological capabilities. After analyzing the responses, 'top management support and commitment', 'project team competence', and 'clear goals and objectives' are the top three success factors identified by Chaudhari and Jain (2019). However, the authors also found that 'use of consultants' and 'end-user involvement' are not significant for successful ERP implementation.

3. RESEARCH METHODOLOGY

3.1. Introduction

In this chapter, the elaborated research problem and the research methods adopted to achieve research objectives are discussed in detail. A qualitative approach with an inductive perspective was used in this study as the main research methodology. Data collection was carried out by conducting telephone interviews with the top and middle management level employees working in construction companies in Sri Lanka. Theoretical Sampling technique was used to select a proper sample, and different analysis techniques were used to analyze the collected data.

3.2. Research Problem

ERP systems specialized for the construction industry, such as Sage, Epicor are presently available in the market. Some well-known ERP systems such as SAP (Systems Applications and Products) can be customized according to the requirements of construction companies. If the company is not financially strong enough to purchase such a commercial ERP system, a free and open-source ERP system such as webERP could be implemented after customizing it according to the requirements of that particular construction company.

A Construction company can obtain many benefits by implementing an ERP system. For example, the top management can view the performance of each project at a glance by looking at the dashboard of the system. That will help to take quick decisions if the project is not moving on the expected track. Hadidi et al. (2017) mentioned that an ERP system is an investment for a construction company. Therefore, most Sri Lankan manufacturing companies, especially garment factories, are obtaining numerous benefits by using an ERP system.

However, companies in the construction sector in Sri Lanka face hindrances that are making the ERP implementation slower, or discontinuing the ERP system use. On the other hand, several other companies are willing to implement an ERP system in the near future and are not capable of implementing it due to some barriers such as ERP system does not align with company business processes, unavailability of domain experts. Therefore, this study aims to identify those barriers effect on

successful ERP implementation in Sri Lankan construction companies. When these companies found ways to mitigate or avoid those barriers, ERP systems could be implemented successfully within a short period. As a result, the companies will become capable of achieving a competitive advantage within their industry sector by successfully gaining the benefits of ERP system implementation.

3.3. Research Framework

As described in the Literature Review chapter, Chan and Sin (2010) carried out a study to observe the association between quality variables as ‘Service Quality’, ‘Information Quality’, ‘System Quality’, and the user satisfaction when implementing an ERP system in construction companies in China. Based on the approach followed by Chan and Sin (2010), the approach of this study has been built to identify the user satisfaction and then reveal the barriers of ERP implementation in construction companies in Sri Lanka, as illustrated in Figure 3.1. In addition to the quality variables described by Chan and Sin (2010), ‘Organization Related Variables’ have also been considered for user satisfaction during this study.

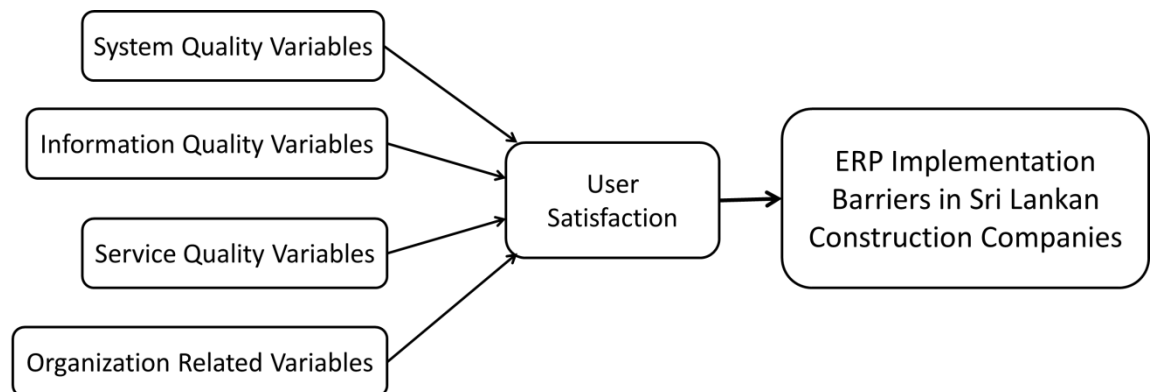


Figure 3.1: Research Framework

According to the approach of this study, when considering a particular factor, such as lack of top management support, unawareness of ERP behavior, the ERP users will decide whether it is a barrier or not in the Sri Lankan context. In other words, a particular factor is categorized as a barrier or not in the Sri Lankan context depending on the user satisfaction.

A considerable number of ERP users highlight certain factors, and those factors were identified as common barriers within construction companies. Further, some other factors were identified that are limited to one or two companies. Hence, the findings of this research will generate insights for companies about the potential barriers of ERP system implementation process, and it would allow such organizations to take necessary actions to mitigate them. Based on the above research framework, each variable applicable in determining the ERP implementation barriers are discussed below.

3.3.1 System Quality Variables

System quality variables include the factors which describe the ERP system. The system's capability of supporting local languages and user-friendliness are some of the examples of this category.

3.3.2 Information Quality Variables

The quality of the data fed into the system and the quality of the outputs of the system are described under the category of information quality variables. For example, customization capability and information security are listed under this category.

3.3.3 Service Quality Variables

The qualities related to the service provided by the ERP vendor is described under this category. Further, the role of the implementation team is also discussed under service quality variables. The support given by the IT department and the status of the training provided by the ERP vendor are some of the examples of service quality variables.

3.3.4 Organization Related Variables

The factors that emerged from the construction company side that affect the ERP implementation are discussed under 'organization related variables'. For example, top management support, and the strength of the internet connection are coming under this category.

3.4. Research Method

The primary purpose of this study is to investigate the research problem discussed in section 3.2. The research method was defined focusing on a broader area and then narrowed down with the progress of the research. This research did not focus on establish relationships between variables using hypothesis testing. Further, this study did not aim at describing the characteristics and functions of the research problem. Therefore, this study is done as an exploratory research.

Rather than considering the financial statistics of the companies, this study explored the social phenomena and social interactions behind the factors affecting ERP implementation. This research focuses on people's views, emotions and feelings towards the system. Even though the systems run on the servers or computers, ultimately they are being used by people at different psychological levels. Therefore, analyzing human perspectives and thoughts is important when identifying the barriers of ERP implementation. Besides, human perception is difficult to capture through a quantitative research method. Hence, a qualitative approach was utilized in this study, considering a sample of management level employees working in the construction companies in Sri Lanka.

The success of ERP implementation depends on how top level managers of those companies overcome the barriers they face during implementation. However, the 'success' is difficult to measure in numbers. Because implementing an ERP system has a number of benefits such as better customer service, user satisfaction, and data security that are challenging to be measured in monetary terms or time values. Further, the companies are not willing to share sensitive financial data such as return on investments of an ERP system.

As a result, user experience and users' point of view on ERP system implementation are essential when identifying the actual barriers of ERP implementation. Additionally, the qualitative approach facilitates unique outcomes that are difficult to acquire from a closed question survey. Therefore, qualitative research methodology is more suitable for this study compared to quantitative methodology. Moreover,

since data is collected without depending on an existing theory or knowledge, this study follows an inductive approach.

Qualitative research methodology consists of several strategies in which case study research, archival research, grounded theory research, and narrative research are some of the main strategies. During the case study research, only one or a few critical, extreme or unique cases are considered. However, according to the Institute for Construction Training And Development (ICTAD), Sri Lankan construction companies have a vast diversification, in which different levels are indicated as C1 to C9. In addition, numerous ERP systems are also available in the market that are used by those construction companies. Therefore, the case study research strategy is not suitable for this research to discover common difficulties of ERP system implementation.

A narrative research methodology is used to analyze participants' experience in a specific scenario or event. It is conducted with the presence of a small number of participants (Saunders, Lewis, & Thornhill, 2012). Therefore, narrative research strategy is also not appropriate for this study, because this study analyzes the stakeholders' experience in different stages of ERP implementation using several companies as a sample that are using various ERP systems.

People are involved in every stage of ERP system implementation in any company starting from the point of evaluation of different ERP systems that could be suitable for the organizational requirements to the point of using the purchased system in day-to-day operations. The stakeholders, who are engaging with that implementation process, recognize the practical difficulties when using the ERP system. They are the real social actors who truly experience the reality behind the ERP implementation. Hence, they have a better understanding of both positive and negative factors which can accelerate or decelerate the system implementation process.

Therefore, the Grounded Theory, which was founded by Glaser and Strauss (1967), was adopted in this study for identifying, analyzing, explaining, and interpreting the actual causes that negatively affects and slows down, cost overrun or discontinuing the ERP implementation in Sri Lankan construction companies.

3.5. Data Collection

The primary data collection method was performed through non-standardized, one-to-one interviews and having discussions with the management level employees and experts in Sri Lankan construction companies. As a result, the respondents got an opportunity to freely elaborate their answers. In addition, past data from the previous studies and statistics from the Department of Census and Statistics in Sri Lanka were also used as secondary data sources for this study.

As described in Chapter 2, numerous literature has identified the barriers and challenges of ERP implementation in other countries relating to both construction and manufacturing organizations. Out of those studies, the most highlighted barriers have been categorized as People, Process and Technology, as defined as the PPT framework, according to the Golden Triangle of Digital Transformation (Hewavitharana & et al., 2019). For example, Cinar and Ozorhon (2015) described 'Reluctance of Employees' and 'Lack of Top Management Support' as 'People' related ERP implementation barriers in Turkey.

Further, the authors categorized 'Difficulty in BPR' as a challenge related to the 'Process' of the company. Chan and Sin (2010) mentioned that 'Unavailability of Multiple Languages' in the ERP system is a 'Technological' barrier for ERP implementation in China. Therefore, the PPT categorization was used as a benchmark categorization in designing the key interview questions of this study. Furthermore, interview questions were designed based on the barriers identified through literature review and the knowledge and experience of the authors of this study.

Since this study was conducted to identify the perspectives of the industry experts, and does not depend on the quantitative data, structured interviews were not carried out. Because, structured interviews use close-ended questionnaires, which limit the respondents to give pre-coded answers (Saunders et al., 2012). It hinders respondents from explaining their real experience associated with the ERP systems.

Since this study considers the broader themes as 'service quality variables', 'information quality variables', and 'system quality variables', unstructured

interviews are also not suitable. If unstructured interviews are conducted, the respondents would talk freely, diverting from the research scope. Further, by the nature of unstructured interviews, the number of interviews would be limited due to the huge amount of data to be processed in the analysis. However, due to the wide range of construction companies and ERP systems, this study required conducting a considerable number of interviews with experts from different atmospheres.

Therefore, as per the above comparison, semi-structured interviews were identified as the most suitable method to collect data for this study as it is aligned with the list of themes and open-ended questions. As a result, respondents will receive an opportunity to disclose their experience and thoughts within the predetermined research scope. Further, this method offers a dynamic approach for the interviewer to follow up the answers given by the interviewee in real-time, which is not possible with structured interviews or surveys (Saunders et al., 2012).

Since employees of the construction companies often work in distant locations such as road or building construction sites, obtaining face-to-face interaction was challenging. Therefore, telephone interviews were carried out with the employees who are working in distant construction sites within Sri Lanka. Before conducting the main interviews, the highlighted categories and key questions were discussed with 3 construction industry experts. The key question areas were changed according to the feedback given by those experts. For example, questions such as the role played by the ERP implementation team were included in the interview questions list after conducting initial interviews with the industry experts.

Data collection was carried out over 3 months of period; 2020 December to 2021 February. The highlighted themes and question areas were emailed to the interviewees one day before the interview. All the interviews were carried out in English language to avoid translation errors. One interview generally lasted for an average of 30 minutes. The order of the questions was changed, or some of the questions were omitted depending on the conversation flow. During the interview, an audio file was recorded, and detailed notes were taken into a Microsoft Word file. Further, respondent's names were not mentioned during the conversation to

safeguard their confidentiality. Additional copies of all the collected data were stored in the Google Drive just after the interview as a security backup.

3.6. Mapping Expected Interview Questions with Objectives

The first two research objectives can be achieved from the answers given for the interview questions. The second objective has four sub objectives since the management perception has been divided into four sections as ‘Service Quality Variables’, ‘System Quality Variables’, ‘Information Quality Variables’, and ‘Organization Related Variables’ (Chan and Sin, 2010). Table 3.1 represents the summary of interview questions that are aligned with the research objectives, and the special points highlighted by the interview participants. The sample interview questionnaire is attached in Appendix A.

Table 3.1: Interview Questions and Objectives Mapping

Objectives	Expected Interview Questions
1. To identify the implementing process of an ERP system in Sri Lankan construction companies.	Q4. Was there any implementation plan with a change management plan including goals and objectives you followed when implementing the ERP? If not, do not you think it is a limitation for the ERP implementation? Q5. Did you analyze the available and required resources (both human and technical/hardware) before implementing the ERP? If not do you think it was a barrier to the implementation process?
2.1 To Capture Management Perception and Observations on System Quality Variables of ERP system in their company	Q8. Does your ERP support native languages (Sinhala or Tamil) other than English? Do you not think that the ERP system not supporting native languages is a barrier for implementation since most of the employees could not understand English well? Q9.1. Does your ERP have ALL the functionalities and the reports that you need to carry out your day-to-day operations?

	Q10.1 What is your opinion on the system's user-friendliness? Do you think that lack of user friendliness is a barrier to implement the ERP system? Q11. Have you found any errors in your ERP system? Usually, what is the frequency that you find errors in your ERP system? Would it be an ERP implementation barrier? Q12. Is your ERP system remotely accessible from any location, any device (such as your smartphone), at any time? If not, is that a challenge to implement the ERP system?
2.2 To Capture Management Perception and Observations on Information Quality Variables of ERP system in their company	Q6. What would you think about the capability of your ERP system to customize according to your company requirements without changing the company business processes? If the ERP system is not customizable, do you think that it is a challenge changing the company business processes according to the ERP features? Q9.2. Does your ERP have ALL the reports that you need to carry out your day-to-day operations? If not available, would you think that it is a challenge when implementing the ERP system? Q10.2. What is your opinion on the security of the ERP system? Do you think that lack of security is a barrier to implement the ERP system?
2.3 To Capture Management Perception and Observations on Service Quality Variables of ERP system in their company	Q3. What would you think about the support given by the ERP vendor? And the interaction with the ERP vendor? (Or IT department, if the ERP is developed by your company's IT department)? Is that enough or do you think that it is a barrier to the ERP implementation process?

	Q7. Was there any dedicated implementation team who is responsible for the ERP implementation process and what do you think about the role played by that implementation team?
2.4 To Capture Management Perception and Observations on Organization Related Variables of ERP implementation process of their company	Q1. What would you think about the support/encouragement/commitment given by top management during ERP implementation? Do you think that not having management support is a barrier to ERP implementation? Q2. What is the level of support given by your co-workers/subordinates for implementing the ERP system? 1. They like to work in an ERP rather than a manual/excel based environment 2. They are reluctant to work with an ERP If they are reluctant to work with an ERP, what are the reasons that they do not like to work with an ERP? Q13. What is your opinion regarding the speed of the internet connection you have at your company and all the construction sites? If it is poor, do you think that it is a limitation in order to implement the ERP system? Q14. Any other comments?

3.7. Overall Summary of the Research Methodology

The research methodology adopted in this study is summarized in Figure 3.2. The outcomes of the literature review were used to outline the semi-structured interview questions. Based on those questions, interviews were conducted with the industry experts working in construction companies. Before conducting a new interview, the previous interview was analyzed to check whether new barriers have emerged from that interview. If new barriers were found, then questions were re-checked for any

adjustment before conducting the next interview. Once the data saturation level was reached, the identified list of ERP implementation barriers was taken into further analysis as described in the Chapter 4.



Figure 3.2: Research Methodology

3.8. Population and Sample Selection

3.8.1. Population

Since this study focused on identifying the barriers of ERP implementation in construction companies in Sri Lanka, the most relevant target audience is the employees, who have the decision making authority in the construction industry, because they have better knowledge and understanding of these issues. **Therefore, both top and middle-level managers in the construction companies in Sri Lanka are considered as the population for this study.**

According to the Sri Lanka Labor Force Survey Annual Report (2019) published by the Department of Census and Statistics, 693,205 employees are working

in Construction, electricity, gas, steam and air conditioning supply, water supply, sewerage, waste management and remediation activities in 2019 (Finance Ministry, 2019). Within that sample, 7.6% of employees are working as managers, senior officials and legislators (Finance Ministry, 2019) in Sri Lanka. **Therefore, the population of this research study is defined as 52, 684.**

3.8.2. Sample

Since the population size is quite large, getting information from all of the top or middle-level managers working in Sri Lankan construction companies is impractical and impossible due to budget and time constraints. Therefore, a sampling technique is used to select a small group of representatives out of the entire population.

In order to address the research problem of this study, the industry experts with ERP systems experience have to be interviewed. If probability sampling technique is used in this study, the chance of selecting any top or middle level manager in any construction company is equal. It creates a possibility of choosing industry experts who are not having ERP exposure, and they will not be able to contribute to this study. Therefore, probability sampling techniques are not applicable for this study.

Several non-probability sampling techniques have been discussed in past literature. Saunders, et al. (2012) mentioned that the Quota Sampling technique is generally used as a part of a survey strategy and most suitable for structured interviews. According to these authors, a large population and large sample size between 2000 and 5000 are considered for the quota sampling technique. Therefore, quota sampling is also not appropriate for this study.

Snowball sampling is another non-probability sampling technique. However, it can be biased since initial respondents will recognize the potential respondents who are similar to themselves and will end up with a homogeneous sample (Lee, 1993, as cited in Saunders, et al., 2012). As a result, the Snowball sampling method is also not suitable for this study.

Comparatively, selecting the sample that is a best fit for answering the research question and objectives is discussed under Purposive Sampling techniques, and ‘Theoretical Sampling’ is a form of Purposive Sampling technique which was adopted by the researchers that follow the Grounded Theory methodology (Saunders, et al., 2012). Further, the ‘Theoretical Sampling’ method is useful to acquire information-rich samples for better results of the study. Subsequent samples will be selected on purpose, depending on the analysis of data collected from previous samples and emergence of new theories until reaching the ‘data saturation’ level (Saunders, et al., 2012). **Since those sampling factors are related to this study, the ‘Theoretical Sampling’ method was used to select the sample out of the population.**

4. DATA ANALYSIS

4.1 Introduction

A comprehensive analysis based on the collected data from interviews has been carried out in this chapter. Several basic procedures and methods of qualitative data analysis techniques have been used to analyze those data. Further, the methods that are not applicable for this analysis are also described in this chapter to justify why those methods are not suitable for this study. The transcribing procedures and data extraction process of initial codes and themes are also described in this chapter. Qualitative data displaying techniques were used to visualize the collected and processed data and accordingly, figures are illustrated using those techniques throughout this chapter.

4.2 Approach to Analysis

As described in Chapter 3, the research question and objectives were not formulated based on existing theories. Similarly, the data analysis has not been organized or directed using any existing theories. Literature from past studies was only used to identify the main areas to be covered and define the scope of the study. Therefore, deductive approaches are not applicable for analyzing the data in this study (Saunders, et al., 2012).

Alternatively, this study explored the collected data and followed up the themes and concentrated on the barriers of implementing an ERP system that has emerged from the interview data. A clearly defined theoretical framework or hypothesis was not developed in this study, because; it would limit the expressions on participants' views, experiences, and social reality. Instead, relationships between the collected data have been identified, and both data collection and analysis were conducted as parallel activities. Hence, inductive approaches were applied for analyzing the collected data during this study (Saunders et al., 2012).

Several well-known inductive analysis approaches exist in the literature, such as Narrative analysis, Analytic Induction, Template analysis, and Grounded Theory Method. As Saunders et al. (2012) suggested, out of those inductive analysis methods narrative analysis emphasizes on analysis of narrative data gathered from a complete

story or narratives regarding a particular issue or aspect without a logical sequence. Since this study did not collect data from ‘story-telling’ methods, the Narrative Analysis method is not suitable for this study.

When applying the Analytic Induction method, data for the case studies need to be collected through observations or exploratory interviews. Therefore, this method can only be applied to limited cases. Hence, it is criticized based on the limited representativeness and generalizability (Saunders et al., 2012). Because this study used semi-structured interviews for data collection, the Analytic Induction method is also not applicable.

Comparatively, the Grounded Theory method is an inductive data analysis approach that aims to develop a theory based on the collected data. Further, this analysis method could be applied for the sample cases that are selected using Theoretical Sampling mechanism, which is a unique sampling technique of Purposive Sampling. The Grounded Theory method fits with data gathered with semi-structured interviews as well, since the data required for the next interview is obtained from the data gathered in the previous interview, until reaching theoretical saturation (Saunders et al., 2012). **Hence, this study adopted the Grounded Theory Method as the data analysis technique.**

As presented in Figure 4.1, different authors discussed the grounded theory method with different philosophies. For example, Strauss and Carbin (1998) explained that grounded theory with the ‘interpretivism’ philosophical influence, which includes three steps as ‘Open Coding’, ‘Axial Coding’, and ‘Selective Coding’. The authors further argue that a researcher could not entirely ignore the literature and prior knowledge of their study area. When applying the grounded theory method for data analysis, that past information could be used to strengthen the overall quality of the research, including data category and theme creations (Sebastian, 2019).

Comparatively, Charmaz (2006) explained the grounded theory with ‘constructivism’ philosophical influence, which consists of two steps as ‘Initial Coding’ and ‘Focused Coding’. Further, this author argues that past literature and prior knowledge of the authors cannot be used to influence or steer the project when the grounded theory

method is applied. However, Charmaz agrees that researchers' prior knowledge and experience can be used to strengthen the quality of the research (Sebastian, 2019).

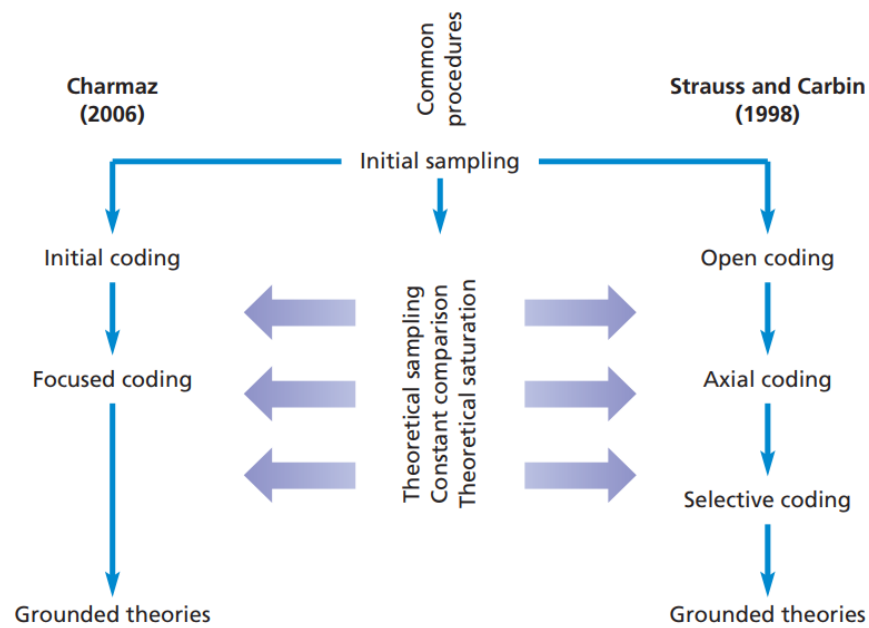


Figure 4.1: Different Grounded Theory Approaches
Source : Saunders, Lewis & Thornhill (2011)

During this study, past literature, authors' experience, and knowledge were only used to obtain ideas about the areas to be covered by the interview questions. That information was not used to direct or shape the data analysis. Only the data collected through semi-structured interviews were used to identify the categories, themes, and relationships among them. Therefore, the grounded theory method defined by Charmaz (2006) is used for the data analysis of this study.

4.3 Data Preparation for Analysis

As it was mentioned earlier, the interviews were recorded in audio files and those recorded audio files were transcribed after each interview. The default voice-recognition mobile application in iPhone 6 was used for dictating the audio recordings. In addition to what participants said, his or her tone of emphasizing some points and interviewees' non-verbal communication were also written down using different color fonts while transcribing the interviews. The company names, vendor names, employees' names or any other clues exposed by the interviewees were not written down in the transcribed document to protect their privacy and confidentiality.

After transcribing the interview, it was emailed to the interviewee for final verification and obtaining confirmation whether their opinion has been written accurately, as they communicated during the interview. It also helped clean the data by correcting any transcription errors and ensure factual accuracy.

After analyzing the first four interviews, it is identified that some participants were praising their ERP system, especially if the systems were developed by their company's IT department, and gave only the positive comments of their ERP system. Since this research's main objective is to identify the barriers to implementing an ERP system, the interview questions have been revised to grab the participants' negative feedback or difficulties faced when implementing the ERP system.

Twelve more interviews were carried out, reaching a total of sixteen interviews. The data saturation has been reached during the eleventh, twelfth, fourteenth, fifteenth, and sixteenth interviews. Even during the thirteenth interview, one new code emerged. Saunders et al. (2012) mentioned the minimum non-probability sample sizes, and accordingly, if the nature of the study is 'semi-structure interviews', the minimum sample size should be between 15 and 25. Moreover, in a similar study done by Nanaykkara, Perera, & Perera (2013) conducted 13 semi-structured interviews with IT experts in the industry to find the factors affecting ERP selection and implementation. Therefore, it proves that conducting 16 interviews were sufficient to derive findings from this study.

The sixteen participants involved with this study are within the age group of 30 to 45 years old, and they are from fourteen different construction companies in Sri Lanka. The designations of the participants are listed in Table 4.1. Three of them are from government sector organizations, and the rest of the thirteen participants are working for private sector organizations. The names of ERP systems used by the participants were represented with anonymity as in Table 4.1 ensuring the confidentiality. Even though the participants are from different companies, some companies are using the same ERP system. For example, two participants from two different companies had experience with the 'ERP4' system. Therefore, those sixteen participants are having the experience of twelve different ERP systems (See Table 4.1).

Table 4.1: Participants' Designation and Used ERP

Interview No.	Participant's Designation	ERP System used by the Participant
1	Construction Project Manager	ERP1
2	Business Lead	Developed by own IT Department
3	Quantity Surveyor	ERP2
4	Regional Engineer (civil)	ERP3
5	ERP Coordinator	ERP2
6	Planning Officer ERP	Developed by own IT Department
7	ERP Project Manager	ERP4
8	Managing Partner	ERP5
9	Project Engineer	ERP6
10	Planning and Procurement Engineer	ERP7
11	Quantity Surveyor	Developed by own IT Department
12	Site Manager	ERP5
13	Quantity Surveyor	ERP8
14	Quantity Surveyor	ERP4
15	ERP Project Manager	ERP2
16	Civil Engineer/ERP Specialist	ERP9

4.4 Initial Coding

Each of the transcribed interviews was saved in a separate Microsoft Word file with a unique file name with the date and the time of the interview, while maintaining the confidentiality of the participants. During the initial coding phase, the collected units of data after transcribing the interviews were separated into analytical conceptual categories (codes). A word, a sentence, or a paragraph was considered as a unit of data according to the context.

It was done using the 'Comments' feature in Microsoft Word. As displayed in Figure 4.2, a particular phrase in the word file was highlighted according to the research question and put a category code as the 'comment'. Those categories were focused on the objective of the study and derived based on both collected data and actual terms used by the interviewees ('in vivo' codes). Each code was given a matching,

unique name. For example, respondent 11 stated “*Those who are older could not learn the system quickly and they did not like to learn the system. We could not change their mind to work in the system.*” and that statement has been categorized under the code ‘hesitate to use the technology’. The same code name was assigned to the similar data units, and two or more code names were assigned for some other data units accordingly.

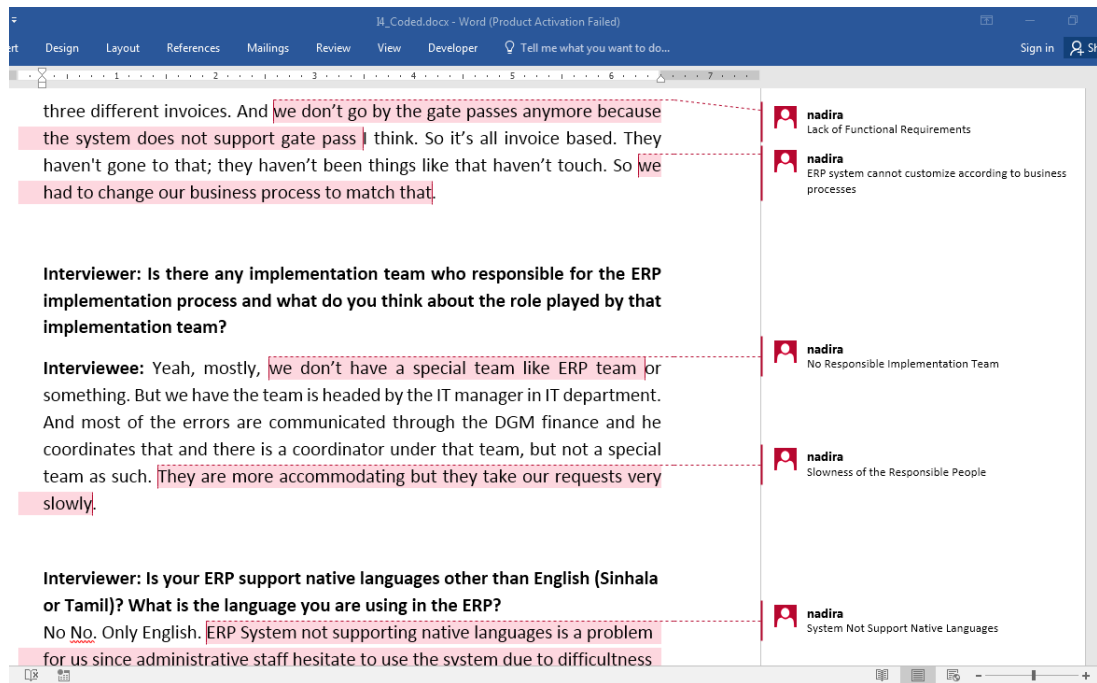


Figure 4.2: Initial Coding in MS Word

After coding the identified barriers using the ‘comments’ feature in the transcribed interviews in Microsoft Office Word during the initial coding phase, those commented data units were copied to a single Microsoft Office Excel worksheet with the interview numbers and the page numbers. Figure 4.3 displays how the initial codes of each interview were tracked by removing the duplicate codes in the Excel sheet.

At the end of coding sixteen transcribed interviews, 172 barriers (initial codes) of implementing an ERP system were identified. The list of initial codes was finalized by removing the repeated codes in all interviews. After removing the duplicate codes, the number of barriers was reduced to 40.

	A	B	C	D	E	F	H	I
1	Ref	view	Initial Codes (Highlighted Duplicates)		Initial Codes (Highlighted Other than First Occurrence)		Finalized Initial Codes	Frequency (N=16)
17	16	1	Slow Internet Speed in Remote Sites		Slow Internet Speed in Remote Sites		Slow Internet Speed in Remote Sites	11
18							Lack of top management involvement	4
19	17	2	Weak implementation plan		Weak implementation plan		Lack of domain knowledge of vendor	2
20	18	2	Bugs in the ERP system		Bugs in the ERP system		Difficulty to re-engineer the business process	7
21	19	2	Lack of system availability		Lack of system availability		Lack of non-functional requirements	9
22	20	2	Lack of top management involvement		Lack of top management involvement		Lack of domain knowledge of implementation	2
23							ERP training manuals not updated	2
24	21	3	Lack of domain knowledge of vendor		Lack of domain knowledge of vendor		Lack of top management support	5
25	22	3	Difficulty to re-engineer the business process		Difficulty to re-engineer the business process		Lack of user training	4
26	23	3	Lack of ERP functions		Lack of ERP functions		Unavailability of responsible implementation	3
27	24	3	Bugs in the ERP system		Bugs in the ERP system		Have to insert previous data	2
28	25	3	Lack of system availability		Lack of system availability		Double work due to continuing the project	6
29	26	3	Lack of non-functional requirements		Lack of non-functional requirements		Long Construction Project Duration	1

Figure 4.3: Initial Codes Categorized in Excel Sheet

Additionally, the number of interviews in which each initial code was repeated has been calculated and mentioned in a separate column as ‘Frequency’ (out of 16 interviews). The identified 40 implementation barriers, along with the frequency, are listed in Table 4.2.

Table 4.2: Final Initial Codes

Ref	Finalized Initial Codes	Frequency (N=16)
1	Not officially entrust ERP responsibilities	5
2	Unawareness of overall behavior of ERP	5
3	Lack of IT knowledge	6
4	Hesitate to use technology	6
5	ERP does not support native languages	5
6	Employees’ reluctance to change	11
7	Weak implementation plan	4
8	Lack of accountability of the vendor	8
9	Lack of change management plan	1
10	Not analyzing resource availability	6
11	Difficulty of customizing the ERP	9
12	Lack of ERP functions	9
13	Bugs in the ERP system	11
14	ERP does not support for mobile devices	3

15	Lack of system availability	5
16	Poor internet connection in remote sites	11
17	Lack of top management involvement	4
18	Lack of domain knowledge of vendor	2
19	Difficulty to re-engineer the business processes	7
20	Lack of non-functional requirements	9
21	Lack of domain knowledge of implementation team	2
22	Outdated ERP training manuals	2
23	Lack of top management support	5
24	Lack of user training	4
25	Unavailability of responsible implementation team	3
26	Have to insert previous data	2
27	Double work due to continuing the existing processes	6
28	Construction projects with long duration	1
29	Fear of Tracking Corruptions	4
30	Fear of Losing of Privacy	2
31	Financial difficulties	3
32	Negative comments of outside stakeholders	1
33	Reducing social interaction	1
34	Changing User Requirements	1
35	Fear of Data Security	1
36	No prior ERP experience	2
37	Organizational Politics and Cultures	1
38	Lack of data or data quality	2
39	ERP implementation taking long time	1
40	Employees have heavy work load	1
Total		172

According to Table 4.2, eleven participants have mentioned that ‘Employees’ reluctance to change’, ‘Bugs in the ERP system’, and ‘Poor internet connection in remote sites’ are the ERP implementation barriers in their organizations. Further, nine construction industry experts revealed that ‘Difficulty of customizing the ERP according to their processes’, ‘Lack of ERP functionalities’, and ‘Lack of non-functional requirements of the ERP systems’ are the ERP implementation barriers within their companies.

Comparatively, ‘Lack of change management plan’, ‘Construction projects with long duration’, ‘Negative comments of outside stakeholders’, ‘Reducing social interaction’, ‘Changing user requirements’, ‘Fear of data security’, ‘Organizational politics and cultures’, ‘ERP implementation taking long time’, and ‘Employees have heavy work load’ are the limitations that were occurred with the lowest frequency (one time).

According to Figure 4.4, the 40 ERP implementation barriers identified by the interviews were graphically visualized in a word cloud, which represents a random display of all the text in initial coding. The font size of the particular word proportionally represents the frequency of that particular implementation barrier.



Figure 4.4: Word Cloud for All the Implementation Barriers

4.5 Focused Coding

During the focused coding phase, the most frequent and significant codes that have been identified during the initial coding phase, were chosen and the data was organized around those identified codes accordingly. The notes were taken in addition to the transcribed interviews and memos were also used to construct those primary categories. Those identified categories were then analyzed by comparing across the different interviews. Therefore, it was a continuous analysis of matching the codes to categories and categories to codes. It helped the continuous emergence of higher-level abstract categories and verification of the existing primary categories.

After reviewing the 40 initial codes, those codes were categorized under six major themes. The six categories were defined from those identified initial codes. They are; ‘Barriers related to management’, ‘Barriers related to employees’, ‘Barriers related to ERP systems’, ‘Barriers related to implementation process’, ‘Barriers related to vendors’, and ‘Barriers related to organizations’.

Table 4.3: Initial Codes Categorized Under Each Theme

Theme	Initial Code
Barriers Related to the Management	Not officially entrust ERP responsibilities
	Lack of top management involvement
	Lack of top management support
	Fear of Data Security
Barriers Related to Employees	Lack of IT knowledge
	Hesitate to use technology
	Employees’ Reluctance to change
	Fear of Tracking Corruptions
	Fear of Losing Privacy
	No prior ERP experience

	Employees having a heavy work load
	Negative comments of outside stakeholders
	Reducing social interaction
Barriers Related to ERP systems	ERP does not support native languages
	Difficulty of customizing the ERP
	Lack of ERP functions
	Bugs in the ERP system
	ERP does not support mobile devices
	Lack of system availability
	Lack of non-functional requirements
Barriers Related to the Implementation Process	Weak implementation plan
	Lack of change management plan
	Lack of domain knowledge of implementation team
	Unavailability of a responsible implementation team
	Double work due to continuing the existing process
	Have to insert previous data
	Lack of user training
	Unawareness of overall behavior of ERP
	Not analyzed resource availability
	Changing User Requirements
	ERP implementation taking a long time

	Lack of data or data quality
Barriers Related to Vendors	Lack of accountability of the vendor
	Lack of domain knowledge of vendor
	Outdated ERP training manuals
Barriers Related to the Organizations	Difficulty to re-engineer the business processes
	Long Construction Project Duration
	Financial difficulties
	Organizational Politics and Cultures
	Poor Internet Connection in Remote Sites

The theme ‘Barriers Related to the Management’ has four initial codes and the theme ‘Barriers Related to Employees’ has nine codes. Seven and twelve initial codes are categorized under the themes ‘Barriers Related to ERP systems’ and ‘Barriers Related to the Implementation Process’, respectively. “Limitations Related to Vendors” has four initial codes, and finally, five codes are listed under “Limitations Related to the Organizations”.

4.6 Discussion

As described in Table 3.1 (Research Methodology Chapter), the interview questions were designed to gather information for the first objective and the four sub-objectives of the second objective of this study. The initial codes emerged from the answers given by the interview participants were categorized under six main themes, as mentioned in Table 4.3. This section describes the data gathered from the sixteen interviews and how those initial codes emerged from the interview answers under each theme.

4.6.1 Theme 1: Barriers Related to the ERP Implementation Process

Under this section, the answers given related to implementation plans, implementation teams, and data required for the implementation processes are discussed. Out of the sixteen participants, three participants had an ERP system developed by their company's IT department. The rest of the thirteen participants took the service of an ERP vendor during the implementation process. Further, some participants have purchased proprietary ERP systems such as SAP and Microsoft Dynamics while some other participants were using free and open-source systems such as webERP.

Different companies follow different approaches in implementing an ERP system. Some companies run manual processes parallel to ERP processes for a limited time period before switching their work entirely to the ERP. Some other companies moved directly with the ERP system by discontinuing their manual processes. Respondent 8 mentioned that both the ERP system and the existing manual process had a parallel running in their company at the initial stages. They had gradually dropped their manual processes with the successful implementation in each module within the ERP. This respondent stated, *"we always tried to run this system parallel with the manual processes and I believe that the implementation was easy due to that parallel run. Then we slowly reduced the manual processes"*. However, during the parallel running, the employees had taken a considerable time even for a small task, since they had to do the same task twice. Respondent 11 had a different strategy of system implementation in their company. First, they had tried to run the ERP in two pilot projects and identified their weak points and success points during the implementation before applying the system company-wide.

Respondent 7 mentioned that they had to run both manual and automated processes together for some of the operations, because the senior employees were reluctant to use the ERP system due to their age and difficulty of moving with the advanced technology. Respondent 4 also mentioned that their management expected the manual system to be carried out parallel with the ERP system. According to Respondent 11, the employees had to put data into the system while continuing the existing manual processes, and the employees were not happy with the double work.

Respondent 16 also stated that continuing the manual process was giving the impression that the ERP system is only creating more work. According to the above facts identified through the responses given by the participants, it is clear that if the companies are not properly planning the transition from manual processes to automated processes in the ERP system, it will result **double work for employees due to continuing the manual processes** and it is a barrier for successful ERP implementation.

The situation of Respondent 12 is different from the others, because they already had separate systems like inventory management system, accounting system, and HRM system before moving to the ERP system. Therefore, they learnt lessons from the previous experiences, and they planned a step by step roadmap with specific goals before starting the ERP implementation by mitigating the issues they faced during the earlier software implementation. For example, this respondent stated that *“once we become expert on billing processes, we started using the CRM module. While handling the customers, slowly we entered the suppliers and started purchases related processes as well”*.

Some companies started implementing an ERP system even without a proper implementation or a change management plan, and after a few months, they identified that not having an implementation plan is a barrier for successful implementation of the ERP system. Respondent 1 did not have a proper change management approach prepared by their company and according to the interviewee they had followed the plans proposed by the ERP vendor without any negotiation. Respondent stated, *“We did not have a very systematic or much aligned scope based implementation and change management plans”*. Based on the vendor’s plans, the goals and objectives with the target dates were announced to the other employees in the company. However, according to the vendor’s contract, they stopped their support after the first six months. As a result, they could not handle the changes in the organization culture and end up with a mix of manual processes and ERP processes. Therefore, **Lack of change management plans** was identified as an ERP implementation barrier in construction companies.

Respondent 5 also had a similar perception of the ERP implementation plan. Because as a client company, they also depended on the vendor's implementation plan with objectives. However, since the Respondent 5 was the ERP coordinator, she had her own plan, including change request logs. Respondent 6, as the ERP implementation manager, also stated, *"There was an implementation plan in my head. The problem was it was not successful as expected"*. According to the study done by Abu-Shanab, Abu-Shehab and Khairallah (2015), having a strong ERP implementation plan with goals that is negotiated with the vendors and announced to all the employees is a critical success factor of implementing an ERP system in companies in Jordan. Respondent 15 mentioned that they had a proper implementation plan aligned with one year and that plan worked as expected. Therefore, it is clear that **not having a plan or having a weak implementation plan** is a barrier to implement the ERP system.

However, a feasibility study had been done in Respondent 1's company before implementing the ERP system, and the gaps of the relevant human resources and other hardware resources such as laptops and routers were identified. That analysis helped them to make planning decisions in advance during the ERP implementation process. However, the resource analysis was not done in Respondent 6's company, and according to his perspective, they were able to manage the available resources without allocating a considerable budget for those required resources. Respondent 7 stated that initially, they studied the entire company's processes and prepared a Software Requirement Specification (SRS) for analyzing the resources gaps. Their goals and the timeline were based on the SRS, and that resource analysis was positively impacted on the ERP implementation process.

Additionally, the company of Respondent 12 understood the limitations related to skillful human resources and took necessary actions before implementing the ERP. Respondent 12 further added, *"Before implementing the ERP system, my company sponsored me for a training course which covered accounting packages. Without having knowledge of accounting packages, it is a little bit difficult to understand the behavior of an ERP system. Then I trained other employees in our company, what I learned through that training course"*. That is how the company of Respondent 12

identified the resources gap before implementing the ERP system and tried to minimize that resources gap to mitigate the ERP implementation barriers. Further, according to Respondent 14, *“Our Company prepared the required resources before starting the implementation. Earlier, we had a manual punching method to track employee signed-in and off. But, with ERP implementation, the company replaced them with finger print machines”*. In that way, the company solved the hardware resources gap as preparation for implementing the ERP system.

In contrast, the implementation team had not done a feasibility study in Respondent 13’s company before initiating the ERP system, and as a result, they experienced the issues such as unavailability of skilled people during the ERP implementation. The company of Respondent 11 also had not done a proper resource analysis before implementing the ERP system and they identified it as a barrier to their implementation process. For example, he stated *“Work with a computer was difficult in some sites, especially in stores; there was not even enough space to keep a computer”*. Additionally, they identified that some sites did not have an internet connection, when they reached that site for ERP implementation. Respondent 15 also mentioned that they had not done a resource analysis of their company due to the lack of experience of their implementation team. This participant stated *“We identified that the implementation was getting slower and slower and lagging due to not having a proper feasibility study”*. As a result, **not analyzing the resource gap before implementing the ERP system** is identified as a barrier to ERP implementation within Sri Lankan construction companies.

Even with a proper implementation plan, the Respondent 13 could not achieve their targets on time since they could not get data from the construction sites regularly. Respondent 10 also noticed that since many users are feeding data to the system, the data quality could not be maintained for preparing quality reports and it negatively affected the ERP implementation process. Therefore, **Lack of Data or Data Quality** is a barrier to implement the ERP system in their companies.

User training also plays a vital role in ERP implementation. The IT department of Respondent 2’s company conducts a training session when a new feature is released.

Additionally, general training is given for the data entry operators for each module separately every three months. Respondent 7 mentioned that they conduct an audit program each month for identifying the employees who need training and conduct the training programs accordingly. In the sense of training, Respondent 12 also has not seen any limitation from the vendors' side.

However, Respondent 8 mentioned that the user training provided by the ERP vendor was inadequate than they expected. Respondent 12 also mentioned that once the system was implemented, their business processes got slowed down due to not having adequate user training, and as a result, the subordinates refused to work in the ERP system. Hence **Lack of User Training** is also identified as a barrier related to the implementation process of the ERP system.

Two employees were assigned to the ERP implementation team from Respondent 1's vendor and both of them did not have much knowledge on construction related functions. Further, Respondent 7 mentioned that their IT department was responsible for the ERP implementation, and they also did not have much knowledge of the construction processes. Most of the time, software developers, software quality assurance people and project managers are the people assigned by the ERP vendor, and they come from IT backgrounds. Therefore, **lack of construction domain knowledge of the implementation team** is a limitation for a successful ERP implementation in the construction industry.

When the ERP vendor is conducting user training for the ERP users, it will be helpful if each person who is using the ERP system has an understanding of the overall system behavior. Respondent 4 mentioned that most of the employees in her company, top to bottom, do not have a clear idea about the overall system. Moreover, those employees do not know how the data they enter would be processed and affected the other business functions. Respondent 14 also mentioned that the subordinates were reluctant to use the system, since they did not have an overall idea about the system, and it was a new experience to them. As a result, they did not see how the data fed into the system connected with the other business processes, and they did not feel the importance of adding data to the system. Hence they continued

the manual processes and did not support the ERP implementation. Therefore, **unawareness of the overall behavior of the ERP system** is also identified as a barrier to implement an ERP system within a construction company.

The ERP implementation team is the responsible party who keeps communication and relationship between ERP vendor, client and other relevant stakeholders. Gavali and Halder (2019) found that having a skillful implementation team is a critical success factor for implementing an ERP system in a construction company. As mentioned by Respondent 1, a dedicated implementation team who is responsible for implementing the ERP system is in place in their organization, and the team consisted of twelve people. Respondent 3 also mentioned that their company has a separate ERP implementation team and that team is maintaining a close relationship with both company employees and the ERP vendor. As the implementation manager, Respondent 6 conducted the training for their employees and the implementation team consisted of five members. He also added that *“Implementation team was very enthusiastic. They wanted the things to be done somehow. They are clever and talented enough to carry out the implementation process”*.

Respondent 9 also mentioned that their company had a separate implementation team, and they were adequately competent and supportive. According to Respondent 11, they had an implementation team who were knowledgeable enough to implement the ERP system, and due to some reasons, they could not transfer the knowledge of the implementation team to other employees. Respondent 13 also mentioned *“There was an implementation team. They were skilled people. They had the idea about the system, and they also wanted to continue it”*. As mentioned by Respondent 14, the IT department of their company was the responsible team to implement the ERP system, and since they had sufficient knowledge, they played a good role in carrying out the implementation processes. The ERP implementation team is composed of three parties, as mentioned by Respondent 15. He further elaborated about the implementation team as, *“I think the people were selected from all the three parties, and I can assure that those people are the most capable people. This is a good mix for the ERP implementation”*. Therefore, it is clear that having a dedicated and

skillful implementation team is a significant factor for the ERP implementation process.

However, Respondent 2's company did not have a dedicated implementation team, and the ERP implementation responsibility was given to the IT department. However, the company of Respondent 4 also did not have a dedicated ERP implementation team. She mentioned, "*We do not have a special team as the ERP team. However, the team we have is headed by the IT manager in the IT department*". Further, she stated that the IT department took actions on their requests very slowly. According to Respondent 5, initially, they had an implementation team to add the old data to generate reports from the ERP system. However, present, she is the only responsible person appointed for the ERP implementation, and it is difficult for her to manage the pressure coming from different stakeholders while implementing the ERP system.

However, during the initial stages of the ERP implementation, Respondent 8, who is the managing director of the company, had given the implementation responsibility to a single person, and he understood that a single person could not handle all the stakeholders. As a result, later, he hired a skilled person to speed up the implementation process. Respondent 16 also depicted that there was no dedicated implementation team in their company. As a result, the ERP implementation responsibility was passed to different managers from time to time, and the system was not smoothly implemented. Therefore, the **unavailability of a responsible implementation team** is considered as another barrier to implementing an ERP system in a Sri Lankan construction company.

Some companies try to get reports from the ERP by inserting previous year's data in addition to inserting daily operational data. Respondent 4 mentioned that adding older data was a time-consuming work compared to the value addition it creates, and no one was responsible for that process. Respondent 9 also stated that accounting and asset management processes took a considerable time to implement since those processes had a huge amount of older data. Therefore, both respondents emphasized

that ‘**having to insert previous data**’ is an ERP implementation barrier for construction companies.

Depending on the company requirements, the processes which are expected from the ERP could also change from time to time. Therefore, according to Respondent 9, users requested different kinds of ERP features and system changes continuously. Once the system features were changed, the user training also should have to be scheduled for particular users. Hence, ‘**changing user requirements**’ is identified as an ERP implementation barrier in a construction company.

4.6.2 Theme 2: Barriers Related to the Management

According to Respondent 1, the department heads and respective senior managers supported the ERP implementation process in the departments that ERP was successfully implemented. Comparatively, implementation is not successful in other departments. He stated about those departments “*I would say that the responsibility was not finalized and it was going back and forth and ultimately the implementation was not happening in those departments*”. Further, he mentioned that the people who are at the operational level do not work in the system unless the ERP system related tasks are defined in their job description because they consider that entering data into the system as an additional work. Respondent 5 also mentioned that the employees expect encouragement like an incentive to work in the ERP system since the ERP system related tasks are not defined in employees’ job roles. Respondent 13 suggested that the employees would use the ERP system if the company management makes it mandatory for them to use. Respondent 14 also stated, “*this system is not an essential thing for the employees and they do not take working in the ERP seriously*”. As a result, **not officially entrusting ERP responsibilities** is considered as an ERP implementation barrier within Sri Lankan construction companies.

According to the statistical analysis done by Ozorhon and Ciner (2015), top management support and commitment was one of the most significant ERP implementation success factors in Turkish construction companies. Due to that high importance, working with the ERP system is one of the factors considered for the annual performance evaluation in Respondent 1’s company. Therefore, both top and

middle-layer employees used the ERP system and supported the implementation process.

As mentioned by Respondent 2, their top management instructed them to not to use any paper-based system and carry out all the operations in their ERP system. Further, Respondent 2 recommended that top management involvement in the implementation process is one of the main positive factors to successfully implementing the ERP system. Respondent 3 mentioned that their top management was very supportive of implementing the ERP system because top management could check the status of all the concurrent projects without any paper work within a concise time. Respondent 4 stated that the ERP system was initiated by the top management, and they were keen on implementing it, covering all the departments.

Since Respondent 8 is the managing director of his company, he pointed out the actions taken by him to implement the ERP system. He had the real requirement of digitizing and converting the company to a paperless office. Therefore, he had put in his maximum effort and provided his support for the ERP system and was involved in different stages of the implementation process. Respondent 7 said that the requirement of an ERP system came from their company director, and using the ERP system emerged as a rule. As a result, all the managers and the subordinate parties have obeyed the director's decision. Respondent 11 said that they had the top management support for implementing an ERP system in their company. He said, *"Top management really wanted to have a system for their day to day operations"*. Respondent 12 also mentioned that they had the top management support at a satisfactory level to continue the ERP implementation because the system requirement came from the top management.

According to Respondent 15, senior management was involved in their organization since it is a government organization, and everyone had to follow the government procedures and regulations. Senior management was also responsible for the ERP implantation since it was part of their job description and the appointment letter. As a result, when the top-level management supports the decisions of ERP systems, the implementation process goes smoothly. Respondent 13 also said that all the

employees would be working without any resistance if the order to work in the ERP system is coming from the top management. From those facts it is clear that both ‘Top Management Support’ and ‘Top Management Involvement’ are essential for ERP implementation in a construction company.

As stated by Respondent 5, there was a mix of top management support for the ERP implementation as several managers were supportive of digitalization. However, there were several other managers who were referring to the conventional, paper-based reports and not interested in generating those reports from the ERP system. Respondent 9 also stated that the support from the top management was at an intermediate level for the ERP implementation in his company.

There are companies that the requirement of an ERP system has emerged from middle layer managers. Respondent 6 stated, *“According to the real situation, there was NO top management support. They did not even look at the system”*. Even though the top management invested a huge amount of dollars for purchasing the ERP system, no one took advantage of it because top management had not been involved in the ERP implementation processes. According to the point of view of Respondent 6, the requirement of ERP implementation should be emerged from the company owners or the top management, not from the middle management or operational level. Respondent 13 mentioned that other than the vendor, initially no one had the intention of implementing the ERP system. According to her, site supervisors were also reluctant to use the system due to the unawareness of the system’s benefits. Respondent 14 said that the top management had an absolute requirement of an information system for monitoring the progress of the road projects. However, due to the knowledge gap, some managers did not like to use the system. Therefore, **lack of top management support** and **lack of top management involvement** are identified as two barriers to implementing the ERP systems within Sri Lankan construction companies.

Due to the unawareness of security standards and the tools available for ensuring system security, the managers of construction companies do not like to keep their company data in a single place. According to Respondent 10, their top management

was not aware of the benefits of the ERP system. As a result, the top management did not take any action to encourage other employees to work in the ERP system. Additionally, she stated that *“Top management had problems like data security and privacy when we put all the data to one system”*. Further, Respondent 2 added that their system has a better mechanism for handling user privileges. Their system can be accessed only within their local area network (LAN) to ensure data security. However, that is again a usability limitation since the management cannot check the status when they are not at the office premises. Further, they cannot get real-time data from remote construction sites. Hence management’s **fear of data security** considered as an ERP implementation barrier.

4.6.3 Theme 3: Barriers Related to Employees

In some construction companies, employees supported the implementation of an ERP system without any hesitation. For example, the subordinates of Respondent 2 supported the ERP implementation process since their work load was reduced. Now, they could generate the reports in a single click which took a longer time to prepare using excel sheets. Respondent 3 also mentioned that employees were enthusiastic about working in the ERP system since they could get a new experience.

However, basic IT knowledge is required to work in an ERP system, and the level of the required IT knowledge could be varied according to the usability, user friendliness, and complexity of the ERP system. However, some senior employees refuse using the system due to the lack of IT knowledge and language barriers. Respondent 1 said that *“Our senior members have years of construction related experience; however, they are struggling with language and the IT infrastructure, and they do not know even how to click the mouse”*. Respondent 4 also said that due to the lack of basic IT knowledge and the language barrier, both subordinates and co-workers took a longer time to handle the ERP system, even for small transactions. Not only junior level people, but also top management has not fully understood the system due to the technology gap. Therefore, **‘Lack of IT knowledge’** has become a barrier to implement the ERP system.

Even though some people have IT knowledge, they hesitate to use the system especially because the employees in the older generation prefer the paper-based processes. Respondent 4 mentioned that *“Employees who are there for a long time in our company and also people who are a bit senior, regarding their age, they are used to using manual processes and they are comfortable using that”*. Respondent 7 also experienced employees’ reluctance due to the age of senior people. Those senior employees were not ready to grab the technology. Respondent 11 mentioned that the employees of the younger generation were willing to work in the system since they could understand the technology.

However, the employees who were in the older generation did not like to learn the systems, and he mentioned that it was difficult to change their mindset to work in a computer-based system. Respondent 14 also confirmed that the employees in the older generation were willing to continue their existing paper-based processes rather than using the ERP system. Further, Respondent 5 also mentioned that two types of subordinates were able to identify as people who are willing to work with new technology and people who are not willing to work in a computer-based system. Due to those factors, it is clear that **‘hesitant to use the technology’** is also a common limitation in the ERP implementation process within Sri Lankan construction companies.

Resistance to change is a natural social behavior. According to Respondent 8, most of the employees understood the benefits of having this kind of a system and supported the implementation process. However, some employees showcased no interest in the system. They resisted change and were willing to continue with the manual processes. Respondent 5 also mentioned that some of her subordinates are naturally resisting change, specifically the senior employees. However, she stated *“Co-workers of mine are very self-motivated and they really want to work in a digitalized environment”*. Respondent 10 mentioned that subordinates were reluctant to change since they were used to the traditional manual processes, and even the civil engineers were not willing to learn the new technologies. Respondent 13 indicated that some employees in her organization have negative thoughts and resisted change when using the ERP system. She stated *“I think those employees do not like to see*

that a system is established and things are running smoothly". Further, Respondent 6 mentioned that about 70% of subordinates liked the system because the system handles a lot of their workload compared to the manual processes. However, about 30% of employees resisted using the system. Most of them did not like to change, and they were willing to continue with their old practices. Hence, '**Reluctance to change**' also is considered as a barrier to ERP implementation.

ERP systems can be used as a tool to track and avoid corruptions happening in any company. Respondent 13 guessed that employees' reluctance appeared due to possibility of eliminating corruptions and frauds through ERP system implementation. Respondent 6 also stated, "*The second point is that employees have a doubt that the system will back track their corruptions. Third thing is employees think that they cannot do any frauds due to the system*". Therefore, this **fear of getting tracked through the ERP system for corruptions and frauds** is also categorized as an ERP implementation barrier related to employees.

The ERP system can be used as a monitoring tool to track the work performed by each employee in the company apart from tracking corruptions. As mentioned by Respondent 6, another set of employees thought that the management might always track their work using the ERP system. As a result, they were reluctant to use the ERP system. Due to that factor, **fear of losing privacy** is also listed as an ERP implementation barrier related to employees.

The existing workload of the employees could also be one of the reasons for their resistance, as mentioned by Respondent 13. Because, when employees have a huge workload, they could not participate in the ERP training and they could not concentrate on ERP functionalities. As a result, those employees rejected using the ERP system. Hence, '**employees have a heavy work load**' is considered as an implementation barrier in the construction sector organizations.

Further Respondent 13 mentioned that subordinates did not support implementing the ERP system since they did not have a prior experience with these kinds of systems. Respondent 10 also stated that even civil engineers of their company did not have a previous ERP system experience, and hence, employees inclined to refuse the

ERP system. As depicted by Respondent 1, their organization now includes the experience of using a computer system for job vacancy advertisements. Hence, **no prior ERP experience** is considered as an ERP implementation limitation within construction companies.

In some construction companies, the stakeholders outside of the company, such as suppliers and customers, had given negative comments about the ERP system. As a result, the users and the managers got discouraged using the ERP system. During the initial stages the speed of the processes in Respondent 8's company were reduced due to not having a proper practice. As a result, the suppliers who were having a strong relationship with the company have pressured the company requesting particular documents and payments quickly. Further, those suppliers and customers blamed the organization saying, "*The owner of that <name of company> performed well with manual processes before implementing a system. He bankrupted after he was trying to implement a system. You also will end up with that kind of a situation if you try implementing a system*". Therefore, managers and users got psychologically de-motivated to use the system, and as a result, they rejected the system. Hence, '**Negative comments of outside stakeholders**' are identified as an ERP implementation barrier in Sri Lankan construction companies.

4.6.4 Theme 4: Barriers Related to ERP Systems

In the Sri Lankan construction industry, some companies develop the ERP system within their IT department, and some companies purchase from an outside vendor. Some companies purchase proprietary ERP systems, and other companies customize free and open source ERP systems according to their requirements. This theme explains the implementation barriers that are common to all of those kinds of ERP systems. The ERP systems used by each participant are listed in Table 4.1.

Since Respondent 2 has a system developed by their own IT department, they developed the business processes according to user requirements. He said, "*most of the time we do developments according to somebody's requirement. Very rarely we change the company process according to the ERP*". According to the view point of Respondent 5, their ERP system can be customized according to most of their

business processes. As a result, they could implement the ERP without a huge reengineering process. However, still, some of the business processes could not be automated since the information flow of those processes is not logically connected to one another.

Respondent 6 also stated that their ERP features could be customized up to 80% to 90% level without changing the company's business operations. Respondent 7 mentioned that since their ERP system was developed according to the global standards, it did not match 100% with their company's business flows. However, their ERP system also can be customized according to the company information flow. Respondent 8 depicted that even though their ERP system has the capability to be adopted according to their business processes, the reports are not up to the expected level. Therefore, the customizing capability of the ERP system is important because users will not like to change their business processes which they have practiced for a long time.

Changing the company business processes that are being used for a long time is riskier than customizing the ERP system (Vlachopoulou and Manthou, 2006). Respondent 1 had difficulty customizing the ERP system that they purchased. They had to change their business processes since their ERP system cannot be customized according to the company requirements. Further, he added, *"Vendor's product was a ready-made product. At any cost, they did not change anything. We had to change our processes from our side to match with the ERP features. For example, we had to change the way we communicate with each other and the way our storekeepers do their daily jobs"*.

According to Respondent 4, since their ERP system has a rigid design, they had to change their business processes according to the features of the ERP system. Respondent 11 also mentioned that there was a conflict between ERP processes and the information flows of their company. He stated, *"ERP system was not capable enough to customize according to the company processes. We had to change our processes according to the ERP system and most of the employees did not like to do it"*. That was one of the major barriers they faced during the ERP implementation.

According to Respondent 9, the ERP system of their company can be customized up to some extent, and other business processes had to be changed according to the ERP system, or had to continue manually.

Respondent 12 mentioned, *“The customizing capability of the ERP was a 50-50 situation. There were situations where the system could not be customized according to our business processes, and there were situations where we could not change our business processes according to the ERP system”*. The ERP system cannot be customized according to the company requirements as mentioned by Respondent 13. Therefore, the respondents’ company had to change their business processes to match with the features of the ERP system all the time. Further, Respondent 14 added, *“We noticed that it was easy to use an excel sheet to manage our business processes rather than doing it in an ERP system. Because carrying out those functions in the ERP system was so complicated”*. Respondent 16 also confirmed that due to the difficulty of customizing the ERP, they had to change their business workflows according to the ERP. Considering the above responses, the **difficulty of customizing the ERP** is recognized as a barrier to the implementation of ERP systems.

The respondents who purchased an ERP system from an outside vendor feel that there are less features and reports, than those who have an ERP system developed or customized by their company’s IT department. Respondent 2 has an ERP system developed by their own IT department. According to him, all the required features and reports are available in their ERP system. Further, their system can email the daily progress reports automatically to the relevant managers at the end of the day. Respondent 9 stated about the system reports as *“Most reports are available as we got them customized”*. The ERP system used by Respondent 14, could also generate adequate and proper reports required to take company decisions.

Respondent 1 also stated that their system is capable of handling standard modules such as Project Management, Accounting, and HRM. However, the modules developed specifically for their requirements, such as the ‘Security’ module, were not capable of catering for their daily operations. As a result, the implementation

failed in those departments. As stated by Respondent 3, *“only 75 percent of reports that we required are available in the ERP system”*. Further, he mentioned that even though their ERP system is suitable for handling the awarded projects, there is a limitation of handling the projects that are in the tendering stage. Respondent 5 also stated that some features were lacking in their ERP system, and the reports were also not adequate for their daily operations.

Respondent 8 stated, *“I believe that the reports and features of the ERP system needs to be more improved”*. Respondent 11 also said, *“System had a limitation of outputs or reports”*. As a result, they had a problem reviewing and analyzing the entered data. Respondent 12 also has a similar thought, and she stated that they could not generate reports 100% matching with their requirements. As per Respondent 15, even though a considerable number of reports were available, all the reports needed for their daily operations were not available in the system. Hence, the **lack of ERP system functions** is identified as a barrier to implement the ERP system in construction companies.

Comparatively, most of the time the companies that have developed or customized the ERP system by their own IT department, did not notice that the features are missing in their ERP system. Respondent 2 has their own ERP system developed by their IT department, and hence, they have all the functionalities required for their daily operations. The IT department demonstrated the new features to the particular stakeholders before deployment. Respondent 2 mentioned *“Before deploying a new feature, we show it to the managers and data entry operators, maybe senior data entry operators, whether they are ok with this”*. As a result, they have not faced any negative comments regarding the system quality after the implementation. Respondent 6 mentioned, *“ERP had the potential to cater all our functionalities, but the implementation failed due to some other reasons”*. Respondent 7 also said that their ERP system has all the functions according to their company’s requirements and standards. According to both Respondent 14 and Respondent 15, all the functions required for their daily operations were included in the ERP system.

Not only the system features, but also non-functional requirements of the ERP system also are equally important when implementing it within a company, as people compare the user-friendliness and usability of the ERP system with their other day-to-day systems and mobile apps. In the sense of user-friendliness, the ERP system of Respondent 1 has a better Graphical User Interface (GUI). He added that *“The system is very friendly and even if someone does not understand anything about systems still he or she can do the things with our ERP system”*.

Respondent 4 also said that their ERP system is user-friendly and *“Anybody can learn the basics, for example, if the usual person who handles the system is not available today, we can easily get another person to do the basic transactions needed to function on a daily basis”*. Regarding user-friendliness, Respondent 7 said that they had gone through the user interfaces of many ERP systems before finalizing the one they have purchased. As a result, they do not have any issues with user-friendliness and mentioned, *“System itself drives the user to achieve the target”*. The idea of the 12th Respondent is that their ERP system also has better user interfaces and they are easy to understand. Respondent 14 stated about the user-friendliness as *“It is user-friendly as we use ‘Facebook’. Most of the features that I worked with can easily be understood without someone’s guidance”*. As Respondent 15 stated, *“According to my knowledge related to security, security of the ERP system is well established”*. Therefore, non-functional requirements are critical success factors while implementing an ERP system in a company since company management is keen on those requirements.

Comparatively Respondent 3 added that their system’s interfaces were also difficult to understand since the system did not provide any information on user navigation. Respondent 5 was also not satisfied with the usability of their system. She mentioned that their system lacks usability as *“It is difficult to follow up without training or guidance. There are many links in a single window. Most of the users are store keepers and quantity surveyors, and according to their knowledge level and technical skills, it is sometimes very difficult to use”*.

According to the judgment of Respondent 6, *“even though the user interfaces are friendly, they are a bit difficult to self-study by just looking at the interfaces. We had to train some people for the same scenario three-four times or sometimes more than that”*. The user-friendliness was not at a satisfactory level according to Respondent 8, Respondent 15, and also Respondent 16. Respondent 11 also mentioned that the user-friendliness of their ERP system is critically low, and *“That is also one of the major barriers to implement the ERP system”*. Respondent 13 believes that their system is lacking in usability. She stated, *“Usability is somewhat lacking in the system. We cannot understand the features just by looking at the system without proper guidance”*. Further, Respondent 14 also noticed that there are some security vulnerabilities in the ERP system. Hence, a **lack of non-functional requirements** is categorized as an ERP implementation barrier related to ERP systems.

Defects or ‘bugs’ in the system are common in any software system. However, according to most of the respondents, the defect rate is high in their ERP systems, and that rate has become a barrier in the ERP implementation process. Even though Respondent 1 did not find any logical or calculation errors, the way reports were presented is not compatible with their company standards. Respondent 2 mentioned that they could find about one or two errors in the system per month at the beginning of implementing a module, and after two-three months, all the defects were eliminated. Since the IT department of Respondent 7’s company is following a standard quality assurance process, they could produce a system with a minimum number of defects. Respondent 8, Respondent 9, and Respondent 12 also mentioned that they rarely found defects in the system.

However, Respondent 3 mentioned that their system has a problem related to user privileges. According to him, *“Anyone can access any feature”*. Further, they found server-side issues with reliability problems. Respondent 4 also stated that they could find an average of one or two system defects per month. Respondent 5 found system errors after releasing a new feature or a report. She stated, *“We found many bugs and sometimes we could not do our day to day operations due to the high bug count. Most of the time, a lot of bugs appear after releasing new functionality or a report. At a rate, we found about five to six bugs per month”*. According to Respondent 6,

during the initial stages of releasing a new feature, they found two to three calculation errors per week, and with time the number of errors became minimal with the time. Additionally, Respondent 9 mentioned, *“There were some errors due to the use of special characters because the system was not capable of handling special characters”*. Respondent 11 also stated that they found a considerable number of system errors, and as a result, system implementation became difficult. During the initial stages of the ERP implementation, both Respondent 13 and Respondent 16 also found about two to five system defects per month. Therefore, **“bugs in the ERP systems”** is considered as a barrier in the ERP implementation process.

Sri Lanka is a country in which most people use ‘Sinhala’ or ‘Tamil’ as their first languages. However, out of the sixteen interviewees, only Respondent 3 had an ERP system that supports either ‘Sinhala’ or ‘Tamil’ languages. However, only five respondents noticed that ‘not supporting native languages’ is an ERP implementation barrier, and the others mentioned that their employees are capable enough to work with ERP systems that are operating in the English language.

Respondent 1 mentioned that even though their system supports some other foreign languages, it is not supporting ‘Sinhala’ or ‘Tamil’ languages and they use ‘English’ as the operational language. Respondent 2 also said that only the ‘English’ language is supported by their ERP system. Further, he said, *“We do not have any requirement for other languages”*. Even though the system supports native languages, Respondent 3 stated, *“We only use English since there is no requirement for changing the language. Still language barrier is not playing a vital role within our company”*.

Comparatively, Respondent 10 mentioned that they have the requirement of supporting the local languages in their ERP system because the operational level employees could not understand English fluently. Further, Respondent 15 also mentioned that their ERP system does not support local language such as ‘Sinhala’ and he thinks of it as a barrier to implement the ERP system. Therefore, **ERP does not support native languages** is also categorized as a barrier related to ERP systems.

Mobile apps for accessing ERP systems are getting popular due to the portability. Chen and Kamara (2005) mentioned that mobile computing extends the boundaries of IT towards construction work sites where the actual construction activities are going on. Therefore, the ability to support mobile devices is essential for the ERP systems that are used by the construction companies. Further, system availability is also an essential factor since stakeholders should be able to check the status of the projects at any time of the day, especially the projects that go on for the entire day.

According to Respondent 3, Respondent 5, Respondent 6, Respondent 12, Respondent 13, Respondent 15, and Respondent 16 their systems could be accessed from any device, at any time of the day, and from any location. Further, they have mentioned that it was a huge advantage for their ERP implementation process.

However, Respondent 1 mentioned that their ERP system could not be accessed from mobile devices. The system could be accessed from any place over the internet only within working hours. That was a significant limitation in their ERP implementation process. The ERP system used by Respondent 2 also could not be accessed by mobile devices, and the system could not be accessed even outside of their company premises since the system is running on their local server, which is not connected to the internet. As a result, they could not get real time data from the construction sites. Respondent 4 also mentioned that they could not access their ERP system from a remote location. The management of Respondent 7 does not allow the employees to access the ERP system from mobile devices since they have bought only a limited number of user subscriptions due to the high price.

According to Respondent 8, even though their ERP system could be accessed from any device, when it is accessed from a mobile device, the system is not user friendly. Respondent 9 said that even though their system can be accessed from anywhere from a laptop or a desktop computer, they do not have a mobile app to access the ERP system. Further, she stated, *“I feel it is better if a mobile app is available for construction sites since people in the construction sites have to do limited work in the system such as issuing GRN, adding work progress, adding fuel issues, and handling petty cash. Further, they have a limited space to keep their computers in a*

construction site”. Respondent 11 said that their system does not consist of a mobile app, and he mentioned that working in the ERP system using the mobile phone’s web browser is very difficult due to the lack of user-friendliness. Respondent 14 also mentioned that their ERP system could not be accessed from mobile devices. As he stated, *“The ERP system can be accessed only from the personal computers (PCs) where the ERP system was specifically installed, and it was a major barrier during the implementation process”*. Therefore, both, **ERP systems do not support mobile devices**, and **lack of system availability** are listed as ERP implementation barriers within Sri Lankan construction companies.

4.6.5 Theme 5: Barriers Related to Vendors

ERP vendor or the company’s IT department is one of the major stakeholders, and they play a key role in the ERP implementation process. Mainly they are responsible for system maintenance, upgrades, and training. Respondent 2 described the support provided by their IT department as, *“the IT department had to do not only the implementing part. They had to do all the things including development and quality assurance from the scratch”*, as their ERP system was developed by them. Respondent 3 also mentioned that their ERP vendor was highly responsive and supportive.

According to the view of Respondent 9, new features and new scenarios appear every day, and therefore, thinking about the logic behind the new features would take time, and it affects the ERP implementation. In that sense, she mentioned that their vendor assists them to solve their problems and fixes defects very fast. Respondent 11 did not see any limitation of the support provided by the IT department to implement their own ERP system. As mentioned by Respondent 14, good training was provided by the vendor and the vendor had an enthusiasm to implement the system. Respondent 15 also has a positive view about their ERP vendor. He said, *“Vendor supported well then and there necessarily up to a satisfactory level”*.

Respondent 16 mentioned that the ERP vendor was very supportive and flexible they requested for customizations. Further, he stated, that *“Availability of the help desk is also appreciable, and vendor’s response speed is also acceptable”*. Additionally, he

mentioned that training programs were also conducted frequently by the ERP vendor, and they were willing to have meetings to discuss the ERP implementation progress. However, according to him, the ERP vendor took a longer time for new feature developments since the vendor allocates only a limited number of developers.

Respondent 4 mentioned that she did not directly communicate with the ERP vendor. However, she has had few meetings where ERP vendor also has participated, and she stated, *“Vendor worked according to their contract. As per the contract, they have given the training for a limited number of people or a limited number of period”*. Respondent 1 also had a similar kind of experience with the vendor. He stated that the vendor provided their service until the end of the contract period and after that vendor did not support even with a payment made to them for those additional services. Further, Respondent 1 stated that the implementation manager of the vendor responded only to the emails and did not respond to any other communication channel such as a phone call. The vendor responded slowly to the defect fixes. As a result, the client representatives had to remind those defects repeatedly during the meetings.

Some of the ERP vendors have not provided their support as expected by the client. Respondent 5 stated, *“I should say initially the vendor was very interested and with the time, that interest was reduced”*. Respondent 6 also explained that the service provided by their own IT department as the ‘vendor’ and according to him, the response of their IT department was very slow. Respondent 8 also was not happy with his ERP vendor because, according to Respondent 8 their vendor was slow to respond to the system defects. During the vendor selection stage, Respondent 10 is considering not only the support that would be provided by the ERP vendor, the ERP vendor’s competence and past performance also.

Respondent 12 said that the service provided by the ERP vendor is at a satisfactory level. She stated, *“I appreciate the support given by the ERP vendor. When I call the vendor for support, they assign a person who has the ability to tackle that problem and provide enough support to continue our business processes”*. However, she mentioned that the vendor took a considerable time even to fix a simple, urgent

defect. For example, they had requested some improvements for system features from the vendor three years back, and still, those features are not available in the system. Respondent 13 stated, *“It is better if we had a little bit more support from the vendor”*. However, she mentioned that they did not have any huge issues with the vendor’s response time. Due to those factors, **‘Lack of Accountability of the vendor’** is considered as an ERP implementation barrier in construction companies.

In addition, Respondent 3 noticed that the vendor’s team did not have domain knowledge of the construction industry to provide good customer service. Respondent 6 stated, *“IT department always tried to customize the system in a very theoretical way. They did not have any practical knowledge about a construction ERP. Even though the theory is correct, those processes are not practical at the operational level”*. Therefore, Respondent 6 advised that to have successful ERP implementation, the system should be developed from a practical angle. Hence, **‘Lack of domain knowledge of the vendor’** is identified as a limitation of implementing an ERP system in a Sri Lankan construction company.

Furthermore, Respondent 3 mentioned that if they had updated training tutorials for each module, they could have learnt the system without supervision. Respondent 5 also mentioned that the user training manuals are not up to date, and the vendor did not take actions to update the training manuals with new feature developments. As a result, she had to face problems when training new employees since she is the ERP implementation manager of the company. Therefore, **‘Not having updated ERP training manuals’** is also derived as a barrier to implement the ERP system in a construction company.

4.6.6 Theme 6: Barriers related to Organizations

Gavali and Halder (2019) recommended having a BPR before implementing the ERP system because then the ERP customization becomes easier. Respondent 5 also mentioned a similar view during the interview. In her view, *“the main barrier for a company to successfully implement an ERP system is that the company processes are not matching with the ERP features”*. However, Respondent 4 mentioned that their company business processes are difficult to re-engineer since it is a government

organization comprises of lengthy processes that are being practiced for a long time. Therefore, **the difficulty to re-engineer business processes** is identified as an ERP implementation barrier in construction companies.

One of the main requirements for implementing an ERP system is a high-speed internet connection. It is needed to retrieve data from the construction sites situated in different areas of the country. However, Respondent 3 mentioned that 3G internet service is also enough to run the ERP system, as their system communicates a small amount of data with the server. Respondent 7 mentioned that they also face the poor internet connection problem in rural construction sites, and they complained about this issue to their internet service provider (ISP). As a result, the ISP provided a dish antenna to strengthen the internet connection. Respondent 11 is satisfied with their ISP and stated, *“We did not notice that internet speed is a barrier for the implementation process. Internet speed was at a satisfactory level to run the ERP system”*. As mentioned by Respondent 12, during the initial stages, they also had internet connection issues, and once they complained to the ISP, they received a better service. Respondent 13 also mentioned that the internet speed is enough to run the ERP system, and it was not an implementation barrier for their company.

According to Respondent 1, 10% of their construction sites do not have a high-speed internet connection for accessing the ERP system. Respondent 4 said that their ISP provided fixed-line internet connections to the regional offices around Colombo, and the internet speed is good in those offices. However, for the temporary sites, the ISP did not provide a solid solution, and therefore, the reliability of the connection is not that good. The same comment has been given by Respondent 5. According to her, their ISP also provided a permanent internet connection for their head office and the offices around Colombo. However, poor internet connections were provided to their project sites in Rathnapura and other rural areas in Galle.

Respondent 6 was also not happy with their ISP since the internet speed is very poor in rural areas such as Angunukolapelessa. He mentioned that, *“Even wired internet connections are not enough in those areas to run the ERP system”*. Respondent 10 mentioned that their ISP could not provide a speedy internet connection to their

construction sites in rural areas. As a result, employees in those sites try to create mobile hotspots and use mobile data. However, most of the time, mobile data is also not adequate even to send an email. Respondent 14 also complained that the internet service was not good enough in rural areas in Trincomalee. The employees in rural construction sites had to work with dongles, and the internet service was not good enough to work with the ERP system. Respondent 15 has high-speed fiber optic internet connections in their Colombo offices. However, the internet connection is poor in out of urban areas.

Further, Respondent 15 stated, *“Poor internet service is a big headache when working with the ERP system in rural areas”*. Respondent 16 was also not satisfied with their company’s internet service provider, and he mentioned, *“Due to the lack of internet service, it has become hard to operate the ERP system in several sites”*. Therefore, looking at the answers given by the interviewees, it is clear that **‘Poor internet service in remote sites’** is a major ERP implementation barrier for Sri Lankan construction companies.

Proprietary ERP systems are highly priced products in the software market. Respondent 7 mentioned that their system was not allowed to be used by the hand-held devices such as smart phones since they have to manage the limited subscriptions. According to him, the price of a user subscription is quite high, and their company could not allocate a huge budget for those user subscriptions. Respondent 10 mentioned that their top management was not willing to purchase a popular proprietary ERP system due to financial difficulties they faced during this year. Due to high user license cost, only a limited number of employees were granted the ERP system functionalities in Respondent 14’s company. As a result, the **‘financial difficulties’** of the construction companies is identified as an ERP implementation barrier in the Sri Lankan context.

Basically, there are two types of construction projects, such as road projects and building projects. Depending on the length and the other environmental factors of the roads or the size and other related factors of the buildings, the project duration may vary from a few months to a few years. During the interview, Respondent 5 pointed

out that the construction projects span across a lengthy period of time are difficult to monitor using the ERP system. According to her, due to the difficulties of data collection and errors due to data entering, the final project management reports could be different from the actual values of those construction projects with lengthy durations. However, those errors are minimal in the short term construction projects. Therefore, '**long project duration**' is categorized as a limitation of an ERP implementation in a construction company.

The organizational culture is unique to each company. According to Respondent 10, they have unique cultures even within different departments such as purchasing, accounts, and administration. Therefore, they face a lot of internal conflicts when they try to integrate those different departments into a single ERP system, and it has become a barrier to implement the ERP system. Hence, the fact '**organizational politics and cultures**' is also identified as an ERP implementation limitation within a construction company.

4.7 Major Research Findings

One of the objectives of this study is to investigate ERP implementation processes which are followed by the construction companies in Sri Lanka. The 4th and the 5th interview questions were asked during the interviews to gather data about the ERP implementation process. According to the gathered data and the discussion under the section 4.6.1, all the companies have implemented the ERP system module by module.

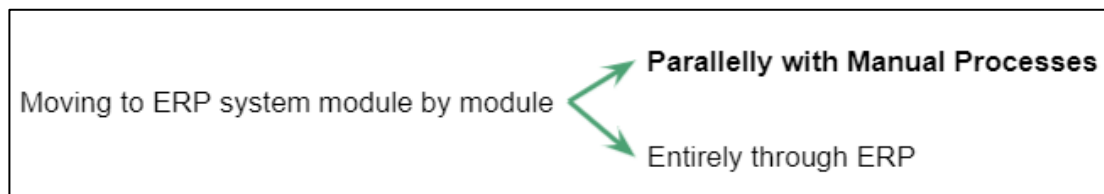


Figure 4.5 : Processes of implementing an ERP system in construction companies

As depicted in Figure 4.5, some companies are moving to the ERP system by continuing their manual processes also in parallel, while other companies started the ERP system by halting their manual process on a planned date. The majority is

following the first approach which is continuing both the ERP system and the manual process in parallel.

Identifying the ERP implementation barriers within construction companies based on the negative expressions disclosed by the respondents during the interviews is also one of the objectives of this study. As shown in Table 4.2, 40 ERP implementation barriers have been identified and six of them are construction industry-specific barriers. They are;

1. Lack of domain knowledge in the implementation team
2. Poor internet speed in remote sites
3. Long project duration in construction projects
4. Difficulty of customizing the ERP system
5. ERP does not support mobile devices
6. Resistance to use the technology

The positive perceptions given by the respondents are used to provide recommendations for the companies which are implementing or willing to implement an ERP system in future. During the 16 interviews, 18 positive perceptions on the ERP implementation have been identified. Those 18 perceptions are listed below.

1. Requirement of implementing an ERP should emerge from company owners, not from the middle management.
2. Several ERPs should be evaluated during the ERP selection stage.
3. A feasibility study should be carried out prior to the ERP implementation.
4. Tasks to be carried out within the ERP system are also included in the employees' job description.
5. Experience on working with an ERP system is included when publishing new job vacancies.
6. Making all the users aware of overall behavior of ERP.
7. The system implemented successfully in the departments where department head is supportive.
8. ERP implementation was successful when supportive facilities and resources are available.

9. The enforcement from the top management for discontinuing the manual processes was helpful.
10. Company business processes were changed rarely in order to be mapped with ERP functionalities.
11. Employees are enthusiastic because it is a new experience.
12. Halting the manual processes after start working in the ERP.
13. Better to do a BPR before starting the ERP.
14. Negotiations with ISP for better internet connections.
15. The ability to access the ERP via mobile devices is a big advantage.
16. Provide special attention for the older people who are reluctant to use the system.
17. A deadline should be set for the vendor's feature modifications (customizations, upgrades etc.).
18. Got the service of a consultant.

5. CONCLUSION, RECOMMENDATIONS AND FUTURE WORK

5.1 Introduction

The major ERP implementation barriers faced by Sri Lankan construction companies discovered from the analysis of this study are summarized in this chapter. Further, recommendations for mitigating those implementation barriers are also discussed in this chapter. The recommendations provided for the implementation barriers in this chapter would be useful to the construction companies which are currently implementing an ERP system and to the companies that are willing to implement an ERP system in the near future.

5.2 Discussion and Recommendations

During the analysis, it was noticed that interviewees highlighted the barriers related to all major parties in the implementation process. Therefore, all the stakeholders in the implementation process must work together with the same goals and objectives to have a successful ERP implementation.

Most of the respondents highlighted the ‘Employees’ reluctance to change’ is an ERP implementation barrier. Further, they mentioned that reluctance is high within the older generation rather than the younger generation, especially among the employees who worked for more than 20 years for a company. As these older employees are used to company business processes for a long time, and as they are currently in the top management positions the reluctance coming from them is comparatively higher. They prefer the manual processes because they are comfortable using that.

Therefore, to overcome this barrier, it is recommended to provide them with a special, personalized training program highlighting how valuable his/her actions performed in the ERP system to the whole company. Further, they should be educated of the advantages of having an ERP system using Return on Investment (ROI) calculations. Even though senior employees resist using the system, it is recommended to assign an assistant to assist him/her to perform his/her actions in the ERP system, especially for generating reports.

Majority of respondents stated that bugs in their ERP system was also a huge barrier for implementing the system, especially during the initial stages of the implementation. One of the respondents mentioned that they could not carry out their daily operations using the ERP system due to the higher number of system defects. Since a considerable number of participants highlighted that ‘bugs’ in the system are a barrier, the ERP vendors should take necessary actions to reduce the ‘bugs’ by following a proper quality assurance (QA) process. If software developers or software quality assurance people do not have enough domain knowledge, it is recommended to provide them with basic construction knowledge and experience in a construction company.

‘Poor internet connection in remote sites’ is also another one of the limitations mentioned by most of the participants. Some respondents mentioned that they had not even wired internet connection faster enough to run the ERP system in some rural areas. Therefore, ERP vendors must consider this limitation and design their ERP systems with minimal data transfers from the side of the construction sites.

As a solution for the poor internet speed, the seventh interview participant mentioned, *“If the internet connection strength was poor, then we put the complaint to the <<name of the internet service provider>>. Then they provided us with a kind of disk antenna for those sites in order to improve the internet speed”*. Therefore, other construction companies also can negotiate with the internet service providers for having a solution to improve the internet speed in construction sites in rural areas.

There are another three ERP implementation barriers highlighted by majority of participants out of the 16 interviewees. They are categorized under the same theme ‘barriers related to the ERP systems’. Those three barriers are ‘Difficulty of customizing the ERP’, ‘Lack of ERP functions’, and ‘Lack of non-functional requirements’. From the point of view of a construction company, these kinds of matters should be considered during the ERP selection process.

The seventh interview participant stated that non-functional requirements got triggered on the ERP system selection stage, before implementation. Therefore, it is recommended that construction companies must request for a live demo system and

provide a hands-on experience even for the implementation team of the construction company before implementing the ERP system because that would help them to get an understanding about the available features, non-functional requirements, and the customizability of the particular ERP system. Further, since these three factors are highlighted by many interviewees, it gives awareness for the ERP software development companies to take necessary actions to develop, test, and produce quality software products; otherwise the end-users will reject the use of that software.

‘Lack of accountability of the vendor’ is also one of the barriers pointed out by many participants. Several participants mentioned that their ERP vendors did not take corrective actions for defects that they found in the system and some even mentioned that vendors did not even respond for their communications. Therefore, those companies were demotivated about their system and it ultimately resulted in failures and unsatisfactory ERP system implementations. Hence, ERP vendors need to take more actions to maintain their customer relationships and should be more responsible for delivering faster and quality customer service to avoid discontinuations of the customer’s business processes. For example, respondent 8 mentioned that they expect even a telephone call from the vendor at least once a month asking whether there are any defects in the system. Therefore, it is recommended that ERP vendors must communicate with the construction company and check the status of the ERP system even though the system is working without any defects. If there are pending defect fixes to be given, ERP vendor must communicate the status of development and planned release dates regularly with the client construction company.

There are nine barriers each stated by a single participant. They are, ‘Fear of Data Security’, ‘Employees having heavy work load’, ‘Negative comments of outside stakeholders’, ‘Reducing social interaction’, ‘Lack of change management plan’, ‘Changing User Requirements’, ‘ERP implementation takes long time’, ‘Long Construction Project Duration’, and ‘Organizational Politics and Cultures’. Those barriers are company specific limitations and the management of those companies should take the necessary steps to mitigate the risk of those limitations before moving forward with the ERP system implementation. For example, the company

management must take steps to release the employees from their routine work and make it mandatory to work in the ERP system for at least one hour daily.

A few points highlighted by the participants during the interviews are important for the management of the construction companies who are willing to implement an ERP system in the near future. As highlighted by the first respondent, the support given by the senior management was a key reason for the successful implementation of ERP in his organization. The respondent 13 indicated that 'top management involvement' is more important than the 'top management support'. Further, the respondent 6, who experienced a failed ERP implementation, recommended that the requirement of implementing an ERP must emerge from the top-management and not from the middle-level managers or operational level employees. Therefore, the companies that are planning to implement an ERP system must note how they should manage the support given by their top management and also their level of knowledge regarding the ERP implementation requirement.

The first respondent's company decided to include 'working with the ERP system' into the employees' job description. Otherwise, employees consider working with ERP as additional work and resist feeding data to the ERP systems. They also took actions to include the previous experience of software systems or ERP systems in their new job vacancy advertisements. Therefore, other companies also can implement such a practice to reduce ERP implementation barriers such as 'Lack of IT knowledge', 'Hesitate to use technology', 'Reluctance to change', and 'No prior ERP experience'.

As mentioned in the literature review, Chan and Sin (2010) identified 'availability of Chinese language in the ERP system' as the most significant factor out of 25 variables in Chinese construction companies. In contrast, in this study, only five participants mentioned the unsupportiveness of Sinhala or Tamil languages in the system is a barrier to implementing the ERP system. Therefore, in the Sri Lankan context, ERP system support for local languages is not a significant barrier for successful system implementation.

5.3 Attaining Research Objectives

- **To identify the implementing process of an ERP system in Sri Lankan construction companies**

The ERP implementation process was identified by the 4th and 5th questions asked during the 16 interviews carried out with the construction industry experts. The participants answered these two questions with a brief introduction about their ERP implementation process. It helped identify the steps they followed and how communication has taken place between the stakeholders during the ERP implementation.

Further, different approaches followed by construction companies when purchasing an ERP system or developing the system by the company's IT department were observed during this study. For example, the first participant mentioned that they did not have a plan. However, the ERP vendor had a plan and his organization combined the vendor's plan into their contract and continued with it. It has been carried out for six months and those plans ultimately became their own plans.

- **To capture management perception and observation of using or implementing an ERP system in their construction companies.**

As described in Chapter 3, the management perception and attitude were captured based on the four main angles named 'System Quality', 'Information Quality', 'Service Quality' and 'Organization Related Factors' (Chan and Sin, 2010). In order to capture those data from the industry experts, as mentioned in Table 3.1, the interview questions were aligned with each of the categories. All sixteen interviews were transcribed, and the main points that participants highlighted were identified by reading those transcribes several times. The transcribed interviews were coded, commented on, and analyzed as described by Charmaz (2006). The same code was used to comment on the similar type of experience in each interview. The process and how the analysis was conducted based on the transcribed interview data were described comprehensively in Chapter 3 and Chapter 4.

- **To categorize those identified perceptions as positive attitudes or negative attitudes for implementing an ERP system**

Different colors were used to highlight the captured data in each transcribed interview according to the positive and negative comments, and those comments were separately documented. Out of those comments, ERP implementation failure points and barriers were taken into separate documents to analyze further and categorized again under six main themes. The steps followed to analyze the negative factors were discussed in the Chapter 4 and the positive factors were discussed within the Chapter 5.

- **To identify the common negative factors for the ERP system implementation and provide recommendations for each of them**

The identified barriers in each interview were compared across other interviews and counted how many times each barrier was repeated within the sixteen interviews. For example, it was identified that ‘Employees’ reluctance to change’, ‘Bugs in ERP Systems’, and ‘Poor Internet Speed in Remote Sites’ were emphasized by eleven participants. Therefore, the recommendations were suggested for those frequently occurring and common barriers mentioned by the participants within the Chapter 5.

5.4 Limitations

This study focused on interviewing the construction industry experts such as project managers and quantity surveyors. However, to have a 360 degree point of view on the research question, it is better to interview and get feedback from the ERP vendors because they also have experience and faced many barriers while implementing ERP systems in construction companies. That will help to identify more barriers and guide all the stakeholders for a better ERP implementation process.

Even though the participants were informed that their privacy was secured at the beginning of each interview, it was noticed that several participants hesitated to reveal the real situation of their company. For example, they did not like to criticize their company’s top management. They might have gotten scared about their job security, and they might have felt that they would face problems by providing the

company information to an outsider. Therefore, it was not easy to obtain the actual situation of ERP implementation of some companies.

Even though the outlined questions were shared with the participants at least a week before, few were not prepared for the interview. As a result, while conducting the interviews, it was observed that they totally depended on their past memories, past experience without using any documentation. They could not remember the things that happened at the initial stages of the ERP implementation about three, four years ago, and they mentioned the recent events a few times during the interview. Therefore, this study is susceptible to both recall bias and temporal proximity bias since some incidents were not considered, and some events gained excessive importance.

In order to reach participants from construction sites in faraway places, this study was carried out with audio telephone interviews. Since the participants could not see during the interviews, participants' non-verbal communication and body language could not be observed. It is a limitation because those facts were also equally important for a better final result. That limitation could be mitigated by conducting video conference interviews with the participants.

All sixteen interviews have been carried out in the English language to eliminate the destructive impact of language translations. However, since all the participants were not fluent in speaking in English language, few participants could not express their ideas adequately.

5.5 Future Work

During this study, it was noticed that the barriers faced by the companies during the ERP selection process and the ERP implementation process are different. Therefore, conducting a separate study on identifying the factors that affect the ERP selection process in Sri Lankan construction companies will benefit the management of the companies that are willing to implement an ERP system in the future.

Further, the construction companies in Sri Lanka have graded from C1 to C9 by the ICTAD according to several factors such as the number of employees, industry

service experience, and the number of concurrent projects handling. As a result, considerable gaps exist in terms of technology, human resources and processes between the companies in each grade. Therefore, conducting a similar research considering only a single grade would be more reasonable and beneficial for those companies.

The human factor plays a major role in ERP implementation and barriers emerged from human factors are vague and difficult to distinguish from one another. Those factors are not even measurable. For example, the two barriers, 'Hesitate to use technology' and 'Lack of IT knowledge' cannot specifically separate into two factors. Therefore, a future study can be done for investigating the behavior of the human factor in the implementation of an ERP system within construction companies.

5.6 Conclusion

By following the grounded theory, the difficulties of implementing an ERP system in Sri Lankan construction companies were identified and analyzed in this study. Since this is a qualitative study, the feelings, thoughts, and experience of the real ERP users have been captured and analyzed. During the data gathering stage, sixteen construction industry experts were interviewed by using a semi-structured questionnaire until reaching theoretical saturation.

Data gathering and data analysis were two parallel processes. When one interview was completed, it was analyzed before conducting the next interview. After transcribing each interview, data analysis was done mainly under two stages. At the end of the initial coding stage, 172 barriers were identified from all the interviews, and it was reduced to 40 barriers after removing the duplicates.

Out of the 16 participants, 11 participants mentioned that 'Employees' reluctance to change', 'Bugs in the ERP systems', and 'Poor internet speed in remote sites' are barriers to implement an ERP system in their companies. 'Difficulty of customizing the ERP', 'Lack of ERP functionalities', and 'Lack of non-functional requirements' were highlighted as ERP implementation barriers by nine interviewees. There were nine limitations such as 'Long construction projects duration', 'Employees have

heavy workload', and 'Organizational politics and culture', which were pointed out by a single participant through the interviews.

During the focused coding phase, the identified barriers in the initial coding phase were categorized into major themes. Six themes emerged when those barriers were categorized under umbrella terms. They were 'Barriers related to management', 'Barriers related to employees', 'Barriers related to ERP systems', 'Barriers related to implementation process', 'Barriers related to vendors', and 'Barriers related to organizations'.

Even though there are 40 barriers identified as the result of this study, some of them are applicable as barriers for implementing any kind of software system in any industry. However, "Poor internet connection in remote sites", "ERP does not support for mobile devices", "Long project duration in construction projects", "Difficulty of customizing the ERP", "Lack of domain knowledge in implementation team" and "Resistance to use the technology", are the barriers that are more relevant and specific for implementing an ERP system in the construction industry.

In the construction industry, the project work is mostly dispersed in multiple locations, including remote sites in rural areas. Using a software system in such an environment is challenging since the internet connection is not strong enough in some of the rural areas in Sri Lanka. Not having mobile support in the ERP system is also another barrier in such situations because these remote sites may not have enough resources and space in order for the users to use a software system running on a computer. Further, some projects are running throughout a long duration, which may be months and years, such as express way constructions, and it was revealed through this study that handling such projects with the ERP systems is more challenging than the projects running across a short duration.

Even though most companies are purchasing an already developed ERP system and customizing it to be matched with their requirements, customizing is not easy all the time. It is difficult in some of the situations especially when different projects are running in different manner even within the same construction company and some

features in the ERP system are coupled with several other features across different modules and it makes customizations difficult.

Usually, the implementation team consists of people from the ERP system vendor's company who have IT background, and they do not have domain knowledge required in the construction industry. Therefore, they are facing difficulties in mapping the users' business scenarios with the system functions. Further, as per the data gathered in this study, there is a resistance from the users to use the system, especially from the senior employees who are not familiar with the technology.

Within the analysis of this study, several recommendations have been suggested by a considerable number of participants in their interviews. The construction companies that are currently engaging in the process of implementing an ERP system could take the benefit of those recommendations. Further, the companies which are willing to implement an ERP system in the near future also could benefit from this study because the management of those companies could take precautions to mitigate the risk of ERP implementation barriers since they are aware of the potential barriers. As a result, the ERP systems can be implemented without any delay and used to obtain a competitive advantage with the expected ROI.

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APPENDIX A: SAMPLE QUESTIONNAIRE

Interview Number	
Date	
Start Time	
Duration	
Designation	
Name of the ERP	

1. In which stage ERP implementation currently in your company? _____
 - A. ERP fully implemented covering all the departments
 - B. ERP implemented in some departments
 - C. Not implemented even in a single department

2. What would you think about the support/ encouragement/ commitment given by top management during ERP implementation? Do you think not having management support is a barrier for ERP implementation?

3. What was the level of support given by your co-workers/subordinates for implementing the ERP system?
 - A. They like to work in an ERP rather than a manual/excel based environment
 - B. They are reluctant to work with in an ERP

If they were reluctant to work with an ERP, what were the reasons that they did not like to work with an ERP?

4. What would you think about the support given by the ERP vendor? And the interaction with the ERP vendor? (Or IT department, if the ERP is developed by your company's IT department)? Was that enough, or would you think it was a barrier for the ERP implementation process?

5. Was there any implementation plan with a change management plan, including goals and objectives you followed when implementing the ERP? If not, do not you think it is a limitation for the ERP implementation?
6. Did you analyze the available and required resources (both human and technical) before implementing the ERP? If not, do you think it was a barrier to the implementation process?
7. What would you think about the capability of your ERP system to customize according to your company requirements without changing the company business processes? If the ERP system is not customizable, do you think it was a challenge changing the company business processes according to the ERP features?
8. Was there any dedicated implementation team responsible for the ERP implementation process, and what do you think about the role played by that implementation team?
9. Does your ERP support native languages (Sinhala or Tamil) other than English? Do not you think the ERP system not supporting native languages was a barrier for implementation since most of the employees could not understand English well?
10. Does your ERP have ALL the functionalities and the reports that you need to carry out your day to day operations? If not available, would you think that it was a challenge for implementing the ERP system?
11. What is your opinion on non-functional requirements of the ERP system; such as usability (how easy to understand/use the functionalities), user friendliness,

reliability and security? Do you think lacking of non-functional requirements was a barrier to implement the ERP system?

12. Have you found any errors in your ERP system? Usually, what was the frequency that you finding errors in your ERP system? Would it be an ERP implementation barrier?
13. Is your ERP system remotely accessible from any location, any device (such as your smart phone), at any time? If not, was that a challenge to implement the ERP system?
14. What is your opinion regarding the speed of the internet connection you have at your company and all the construction sites? If it is poor, do you think it was a limitation in order to implement the ERP system?
15. Any other comments?

APPENDIX B1: INTERVIEW TRANSCRIPT PARTICIPANT 1

Interview Number	01
Date	2021 January 02
Start Time	08:21
Duration	Min 25:32
Designation	Construction Project Manager

Interviewer: In which stage ERP implementation currently in your company?

A. ERP fully implemented covering all the departments

B. ERP implemented in some departments

C. Not implemented even in a single department

Participant: I will go with answer B, because still we are yet to complete the implementation. But some departments, fully implemented.

Interviewer: What would you think about the support/ encouragement/ commitment given by top management during ERP implementation? Do you think not having a management support is a barrier for ERP implementation?

Participant: Now if I consider the departments which are already implemented, those top management people, I mean, department head, himself, and the respective senior managers, they are very helpful in the process of implementation and they took the entire responsibility of the implementation.

But in the other departments, I would say it was going back and forth for sometimes and what happened was that the responsibility was not finalized ultimately the implementation is not happening in those departments. I would say the departments that successfully implemented senior management support were there and that was enough.

Interviewer: What was the level of the support given by your co-workers/subordinates for implementing the ERP system? If they were reluctant to work with an ERP, what were the reasons that they did not like to work with an ERP?

Participant: Yeah, what happened was now I will differentiate the 3 levels: the top management, middle management and bottom line. So what happens as a project manager in the middle management we try to get ourselves in the organization senior management. Therefore, if we go with these systems, then we are much more likely to become a senior member of the organization. Therefore, myself and the colleagues were very interested and keen in the implementation and all the project managers and like, for say, the project coordinators and directors were much into the implementation. But in the case of the bottom line, the labor and the people who are doing the day jobs, unless otherwise defined in their job description, they are not doing. It is not happening.

The reason was like let's say for instance, a store keeper, his day job is looking after the warehouse and doing this and that. But if we say put this data into the system that is outside of his scope. So he doesn't know about any system and what is going with these systems and all that. Therefore, what we did initially was take these kinds of statements in their job description and even advertising onwards we say we want someone with capability of systems and IT. So then only we took the relevant human resource into the organization and to the bottom line and then it was going.

Yeah, technology was one barrier and their perspective, sometimes these systems are in English. So some of our senior members have lot of experience, however they are struggling with language and the IT infrastructure, and they don't know how to and there are some people, they do not know even how to click the mouse. They were trying, but that was not happening. But what we do was we trained them but the moment we put these things in their job description then, that was their responsibility and they were doing.

Interviewer: What would you think about the support given by the ERP vendor? And the interaction with the ERP vendor? (Or IT department, if the ERP is developed by your company IT department)? Was that enough or would you think it was a barrier for ERP implementation process?

Participant: So what actually happened was this assignment of contract, from our side we dedicated an implementation team and from their side they dedicated two persons for the implementation team. And as per the agreement, they are there for six

months. They were very helpful, I mean they even came to the office and sometimes we had online meetings and they were doing everything for the first six months. Then onwards what happened was in contracts terms, they were not available but still we could pay them and got what we wanted. Therefore, I think from the vendor's side they did their job.

We contacted the person who was the vendor's implementation manager and his team. We have to email them and then only we could get their help. The response time depended on the inquiry. For simple stuff they responded within 6 hours and the critical thing, they took 1 month period sometimes. But what happened was when we pushed them then they were doing otherwise it was stuck there for some time and we have to remind them again in another meeting and it is getting happening. And that was what happened.

Interviewer: Was there any implementation plan with change management plan including goals and objectives you followed when implementing the ERP? If not, do not you think it is a limitation for the ERP implementation?

Participant: Actually if I say the truth, we didn't have such a plan. But from the vendor side, they had clearly defined plans. That was stick in to the contract as well so they were there for six months and these will become the ultimate goals upon implementation and these are the things that they will do, these are the dates and these are the things that they would come and such a plan they gave to us and accordingly we guided our team understanding what is going to happen in first 6 months' time and what we can expect at the end of each month, say first month what is going to happen and then second month what is going to happen. So from our side the respective people, money and time we allocated and that is how it happened. We didn't have a very systematic or very aligned scope based implementation plan.

Interviewer: Did you analyze the available and required resources (both human and technical) before implementing the ERP? If not do you think it was a barrier to the implementation process?

Participant: Yeah, what happened was, the vendor directly asked a feasibility report from us that was like they wanted to check whether we have these and those facilities

such as routers, whether we have enough human resources. Due to the vendor's request we did this feasibility study. And we understood that remote locations like project sites and some highway project remote locations those resources are not available. Initially we didn't have those human resources. What we did was mid of the implementation, after 3 months, we recruited more people who have IT capabilities.

Interviewer: What would you think about the capability of your ERP system to customize according to your company requirements without changing the company business processes? If the ERP system is not customizable, do you think it was a challenge changing the company business processes according to the ERP features?

Participant: No. The vendor's product was a readymade product. At any cost, they didn't change anything. I mean, they have the product as it is and didn't make any changes. What they did was they fixed the bugs. But we had to change our processes from our side matching to the ERP process. We had to change the way we communicate with each other and the way our storekeepers do the daily job we had to change. They didn't change anything.

Interviewer: Was there any dedicated implementation team who responsible for the ERP implementation process and what do you think about the role played by that implementation team?

Participant: From the vendor, there were two people coming. That was the implementation manager and the person who did data entry and daily routine. From outside, we had like 10 people in the team, led by the IT department. They had the responsibility given, 3 department heads from construction department, security department, and procurement department. Because we are very much interested in both security and procurement. 3 members from each department and altogether 10 people from our side.

Interviewer: Does your ERP support native languages (Sinhala or Tamil) other than English? Do not you think ERP system not supporting native languages was a barrier for implementing since most of the employees could not understand English well?

Participant: No, in the case of language it is only English. But I think some foreign languages are there. It was only in English for us. Sinhala and Tamil also not there.

Interviewer: Does your ERP has ALL the functionalities and the reports that you need to carry out your day to day operations? If not available, would you think that it was a challenge for implementing the ERP system?

Participant: What happened was, in feasibility study we understood that the construction department, all the reports and all the routine stuff we do system was capable. Therefore, it is very successful for the construction department. But when it comes to the security department, the transportation, security, the people in and out those are not there in the system. We tried and requested the changes and things that we want from the department perspective. But it didn't happen. So Ultimately in the context of the security department, the implementation was not successful. Therefore, the successful implementation happens if the facilities are already there in their product. But in the other departments that was due to those what we requested from them was not there in their system. Some of there and some of not there.

Interviewer: Can I know what did you mean by the security department and the role of that department?

Participant: The security department of our context is one of the most important departments. All the issue of vehicles and issue of human resources will be done through the department of security. Therefore, we want to have a list of people, resources and sometimes even money taken out from the head office, that was not done through the system. It was utterly done manually why the system was not capable of handling that. But in the concepts of procurement, purchasing, the construction work monitoring, progress monitoring, those were there in the system and it was successful. Even in the finance department it didn't happen why they had a finance module in their system but still we didn't adopt it, the reason was it was not up to our standards, and sometimes arguments happened and we didn't go with finance.

Interviewer: What is your opinion on non-functional requirements of the ERP system; such as usability (how easy to understand/use the functionalities), user

friendliness, reliability and security? Do you think lacking of non-functional requirements was a barrier to implement the ERP system?

Participant: Actually, in the case of security, I don't have any idea. then, interface, it is quite good. It is very friendly and even if someone doesn't understand anything about systems even he or she can do whatever the things. It is a very simple and friendly design and not too complex. The only issue was the language other than that it is user friendly.

Interviewer: Have you found any errors in your ERP system? Usually, what was the frequency that you founding errors in your ERP system? Would it be an ERP implementation barrier?

Participant: The calculation errors were not there. Everything was fine with calculations. But, some reports, the way those reports are presented, sometimes those are not compatible. For an instance, let's say we want a date in a report. But calculation errors, buttons not working, those are not there. It was perfect. The only issue is that sometimes when we request something in this system we can setup certain reports, when we setup a report and when we open it, what we initially set is not there. I think it is a bug and that was there. Like we tick a time, we tick a date, we tick the person's name but when we open it, the time column is not there. And the frequency is like in the financial year, our financial year is from January 01st to 31st of December. The initial 6months, there were zero bugs found. The system was working fine. But at the moment of December when we are finalizing our budget, many errors come, the reason is we are doing new things and new people are getting into the system, the number of the users using the system is now high. Therefore, at the end of the financial year we found these errors.

Interviewer: Is your ERP system remotely accessible from any location, any device (such as your smart phone), at any time? If not, was that a challenge to implement the ERP system?

Participant: Yes, via the internet we can get into the system, but not from the phone. From the smart phones we cannot enter into the system. Even via tab we cannot enter the system. And the system is available within the working hours of the organization. If we want an extension, in advance we have to request. If we are working more than six hours, we have to make a request. These features are there also in the system.

Interviewer: What is your opinion regarding the speed of the internet connection you have at your company and all the construction sites? If it is poor, do you think it was a limitation in order to implement the ERP system?

Participant: We have five offices. Highway project office has all the facilities. Rough estimation is 65% of locations have 2Mbps speed of connections. Rest of the locations are less than that speed. And 10% of the locations do not have internet connections.

Interviewer: Any other comments?

Participant: I think everything is covered

* ** End of the Interview ***

APPENDIX B2: INTERVIEW TRANSCRIPT PARTICIPANT 4

Interview Number	04
Date	2021 January 03

Start Time	14:30
Duration	Min 16:24
Designation	Regional Engineer (Civil)

Interviewer: In which stage ERP implementation currently in your company?

A. ERP fully implemented covering all the departments

B. ERP implemented in some departments

C. Not implemented even in a single department

Participant: In our organization there are two main sectors and I'm in maintenance. We have a sales section also. For the sales and finance section we are using SAP. And there is a general EMIS system developed by our own IT department for small, small functions. Like maintenance and things like that. But SAP is used for our stores, sales and finance.

Interviewer: What would you think about the support/ encouragement/ commitment given by top management during ERP implementation? Do you think not having a management support is a barrier for ERP implementation?

Participant: Our top management is the one this is initiated. They are keen on implementing it. But I think there is also gap between understanding the technology and the procedure at the top level also. Because all the functionalities done by the lower level and they don't exactly know how the process work. So I would say partial support from the top management. But they want to implement it. They want to technologically progress. But bit difficult because they understand it fully I think

Interviewer: What was the level of the support given by your co-workers/subordinates for implementing the ERP system? If they were reluctant to work with an ERP, what were the reasons that they did not like to work with an ERP?

Participant: Yeah, there is a, there has been a there are already very lengthy manual processes that has been there for a long time. Right? So I would say co-workers in terms of people who are in the same level as me may be engineers or the people who are in the same age group as me, they prefer handling the ERP for small, small administrative work than handling lot of paper work, if it is fully implemented. But

subordinates, in the terms of other administrative staff like clerk, store keepers, cashiers, even cashiers would prefer, but people who are there for a long time in our company and also people who are bit senior, regard to their age, prefer the manual system. Because they are used to it and they are comfortable of using that. They have a small lack of knowledge of basic IT skills it takes them a longer time to handle the ERP even for a small transaction and also there is a language barrier because they don't understand, what you call, 'operational language' of the ERP systems. So prefer the manual systems, the subordinates.

Interviewer: What would you think about the support given by the ERP vendor? And the interaction with the ERP vendor? (Or IT department, if the ERP is developed by your company IT department)? Was that enough or would you think it was a barrier for ERP implementation process?

Participant : I haven't dealt directly with a vendor. Because even under my region people who are directly handling the people who are in operational level have been trained. However, I was there with them in few meetings and what I feel is they are neutral they are work according to their contract, training contract. They have trained I think about they have given training for limited number of people or limited number of period and we contact, we communicated any of the difficulties that we have through our IT department. But so far they have been able to address or help us with our solutions through our IT department regarding the ERP system.

Interviewer: Was there any implementation plan with change management plan including goals and objectives you followed when implementing the ERP? If not, do not you think it is a limitation for the ERP implementation?

Participant: I don't know the exact implementation plan but the goal is to convert the entire manual system mostly the sales transactions and their finances related to the sales and the supplies division to function on the ERP system and also to eliminate the miscellaneous administrative work of the company that requires unnecessary procedures like application of leaves or maintenance requests things like that. But I don't know whether they have, I'm not aware of the implementation plan. May be partial first and then they plan to do it, because there is a lot of dual actions still going on. We do manual and then the ERP as well.

Interviewer: Did you analyze the available and required resources (both human and technical) before implementing the ERP? If not do you think it was a barrier to the implementation process?

Participant: I'm sorry I don't have an idea about this since when I was joining the company ERP implementation has started and I'm not in a position to provide information to available resources. No idea about this.

Interviewer: What would you think about the capability of your ERP system to customize according to your company requirements without changing the company business processes? If the ERP system is not customizable, do you think it was a challenge changing the company business processes according to the ERP features?

Participant: Some capabilities of our ERP system to match our requirements, you said? I would say it is a bit rigid and I would say some processes are still under construction for an example some processes in sales sections we have to do some production of like let's say for one invoice we need to produce several gate passes when material have been taken out. But with the new system was unable to do that, so we have to for one may be customer who wants to take more than two three loads of the same thing they have to, we have to give two three different invoices. And we don't go by the gate passes anymore because the system does not support gate pass I think. So it's all invoice based. They haven't gone to that; they haven't been things like that haven't touch. So we had to change our business process to match that.

Interviewer: Was there any dedicated implementation team who responsible for the ERP implementation process and what do you think about the role played by that implementation team?

Participant: Yeah, mostly, we don't have a special team like ERP team so something. But we have the team is headed by the IT manager in IT department. And most of the errors are communicated through the DGM finance and he coordinates that and there is a coordinator under that team, but not a special team as such. They are more accommodating but they take our requests very slowly.

Interviewer: Does your ERP support native languages (Sinhala or Tamil) other than English? Do not you think ERP system not supporting native languages was a barrier for implementing since most of the employees could not understand English well?

Participant: No No. Only English. As I mentioned earlier also operational language is a barrier to implement the ERP. Better if the system supports even ‘Sinhala’ language.

Interviewer: Does your ERP has ALL the functionalities and the reports that you need to carry out your day to day operations? If not available, would you think that it was a challenge for implementing the ERP system?

Participant: Functions that they require us to, that they expect us to so far manage on the ERP are available. But not all functions are there. And also some reports have been combined into one report and yeah, the reports are ok. The reports we can get. And that has eliminated some paper based reports also because of the ERP.

Interviewer: What is your opinion on non-functional requirements of the ERP system; such as usability (how easy to understand/use the functionalities), user friendliness, reliability and security? Do you think lacking of non-functional requirements was a barrier to implement the ERP system?

Participant: I think the system developed by our IT department is not very secure. I think anybody can access it. But SAP system is quite secure you need if the function, if the user changes, you need to inform in advance, to change the security and things like that. But both of the interfaces are quite friendly. Anybody can learn the basics, now for an example, if the usual person who handle the system is not available today, we can get easily get another person to do the basic transactions needed to function on a daily basis.

Interviewer: Have you found any errors in your ERP system? Usually, what was the frequency that you founding errors in your ERP system? Would it be an ERP implementation barrier?

Participant: There are, there are. May be like one or two per month.

Interviewer: Is your ERP system remotely accessible from any location, any device (such as your smart phone), at any time? If not, was that a challenge to implement the ERP system?

Participant: I think SAP can’t access remotely. But the system developed by our IT department anybody can access remotely.

Interviewer: What is your opinion regarding the speed of the internet connection you have at your company and all the construction sites? If it is poor, do you think it was a limitation in order to implement the ERP system?

Participant: Yeah, there are sites mostly around Colombo and other places. We have different suppliers for our different, different sites. But mostly permanent base, for an example, regional offices have permanent internet connections from land telephone lines. Those internet connections are good. But some temporary base like sales centers or temporary sites they don't have a permanent connection. They work through routers. So that's bit unreliable at sometimes. If you haven't paid a bill or the reliability is not that good.

Interviewer: Any other comments?

Participant: I think what our company is lacking also what most companies are lacking an overall introduction of the system from middle to the higher management. So basically they give a small idea to the top management and then the operational level is trained but the middle management; like for example I and people in my level are not fully aware of what happens we have to learn our own. And also in this our SAP also there is a lot of back data that you need to enter. So the fully implementation would take a long time. So may be back data shouldn't be made necessary unless the company need old reports and the false in our system also that they expect the manual system also to be carried on as well as the system. So people are not serious about following the systems, so like for example, POs are still printed, GRNs are still printed whatever that is produced from the system. So if it can be fully systemized, they would get seriously and go forward. But because of the manual system also still ongoing I feel like the operation level doesn't take it very seriously.

*** End of the Interview ***

APPENDIX B3: INTERVIEW TRANSCRIPT PARTICIPANT 5

Interview Number	05
Date	2021 January 11
Start Time	16:04
Duration	Min 14:01
Designation	ERP Coordinator

Interviewer: In which stage ERP implementation currently in your company?

A. ERP fully implemented covering all the departments

B. ERP implemented in some departments

C. Not implemented even in a single department

Interviewer: What would you think about the support/ encouragement/ commitment given by top management during ERP implementation? Do you think not having a management support is a barrier for ERP implementation?

Participant: So, should I give the condition of my company or my opinion?

Interviewer: Yeah, your company situation?

Participant: Ah! Ok, In our company when we talk about top management it depends on the person. I should say one of our top management, one person is very fond of digitalization. So he wants any report from ERP. But others are not very supportive and they are not... I can't say they are not supporting but, sometimes they are using, only referring to conventional, old reports. They are reluctant to use ERP reports, so at that point I think their action makes some barriers to implement the ERP.

Interviewer: You mean, 50-50 management reluctant?

Participant: Yeah, Yeah.

Interviewer: What was the level of the support given by your co-workers/subordinates for implementing the ERP system? If they were reluctant to work with an ERP, what were the reasons that they did not like to work with an ERP?

Participant: As a mark, it is also 50-50. I mean, there are some co-workers with me they are very self-motivated and really want to work in a digitalized environment. And some of them

needs some encouragement like salary incentive for work in ERP and some of are very reluctant to use ERP. So it is 50-50.

Interviewer: So what do you think what are the reasons for that reluctant?

Participant: Most of the time I think some of their attitudes. And nature of resistant to change. That type of reasons and also their age. It also a reason and some of them are don't have some technical skills. I mean using the computers. Those type of things they are some of them are new to those things and yeah. I think those are the reasons and double work. One reason, double work. Because our top management need routine conventional reports and we have to produce both reports.

Interviewer: What would you think about the support given by the ERP vendor? And the interaction with the ERP vendor? (Or IT department, if the ERP is developed by your company IT department)? Was that enough or would you think it was a barrier for ERP implementation process?

Participant: I should say initially the vendor was very interested and with the time, that interest is reduced. I think because it is with long project duration. And some resistance come from our side. However the vendor provides the service continuously, even though we are not doing payments on time. But..

Interviewer: What would you think about the training provided by the ERP vendor?

Participant: Training is, initial training was adequate. Because they trained me first. After that they are not training much, so I'm doing all the work. However, anytime I can contact the coordinator and get the support. It's ok. But I should say training manuals are not up to date.

Interviewer: Was there any implementation plan with change management plan including goals and objectives you followed when implementing the ERP? If not, do not you think it is a limitation for the ERP implementation?

Participant: Ok, I came to this job after the implementation is started. Ok? So I didn't have got the chance to prepare any implementation plan. But from the vendor side, there was an implementation plan with goals and dates. And after I appointed to digitalization division in our company, I had prepared my own document with my goals and plans. So I followed that document as goals when I'm following up vendor for doing customization. And I keep some change request log for my reference. That's all.

Interviewer: Did you analyze the available and required resources (both human and technical) before implementing the ERP? If not do you think it was a barrier to the implementation process?

Participant: I didn't participate in that action. But they have done it, they have compared some other ERP systems and have selected this.

Interviewer: What would you think about the capability of your ERP system to customize according to your company requirements without changing the company business processes? If the ERP system is not customizable, do you think it was a challenge changing the company business processes according to the ERP features?

Participant: I think most of the processes were able to customized according our company process. But still some modules are not customized, I think due to the complexity of the processes and sometimes they are not logically connected. Yeah. Most of them are customized.

Interviewer: Was there any dedicated implementation team who responsible for the ERP implementation process and what do you think about the role played by that implementation team?

Participant: Ok, initially we had a team for backlog data entry actually because accuracy of the data is very critical for successful implementation. After that I'm only there for separated person for the ERP. No separate staff for ERP.

Interviewer: Does your ERP support native languages (Sinhala or Tamil) other than English? Do not you think ERP system not supporting native languages was a barrier for implementing since most of the employees could not understand English well?

Participant: No support for native languages. Only English. But I don't think it a problem for our company.

Interviewer: Does your ERP has ALL the functionalities and the reports that you need to carry out your day to day operations? If not available, would you think that it was a challenge for implementing the ERP system?

Participant: No. Not all are there. There is a lacking part.

Interviewer: What is your opinion on non-functional requirements of the ERP system; such as usability (how easy to understand/use the functionalities), user friendliness, reliability and security? Do you think lacking of non-functional requirements was a barrier to implement the ERP system?

Participant: I should say it is difficult to follow up without training, I mean without guidance. I have to give some explanations for them to understand those things. User

friendliness, there is also a problem. So many links in a one window. So most of the users are storekeepers and quantity surveys. And according to their knowledge level and their technical skills sometimes it is very difficult to use it. Reliability is ok.

Interviewer: Have you found any errors in your ERP system? Usually, what was the frequency that you found errors in your ERP system? Would it be an ERP implementation barrier?

Participant: Yeah, I have found. Most of the time, after releasing new functionality or a report. I can find about one bug per month.

Interviewer: Is your ERP system remotely accessible from any location, any device (such as your smart phone), at any time? If not, was that a challenge to implement the ERP system?

Participant: Ah Yes. At any time, from any location, and from any device possible.

Interviewer: What is your opinion regarding the speed of the internet connection you have at your company and all the construction sites? If it is poor, do you think it was a limitation in order to implement the ERP system?

Participant: Yeah, not all islands, but some parts of the country. There are some problems. Apart from head office and site offices located around Colombo, we also have some sites in Rathnapura and other rural areas in Galle. They are having some internet connection problems. connections are slow, and there is a problem.

Interviewer: Any other comments?

Participant: I think before implementing ERP system company should do a business process re-engineering; I mean, their processes and ERP processes we have to match and come to one point. I think after that, implementing will be succeed. Because the main the reason is not matching the processes and ERP.

*** End of the Interview ***

APPENDIX B4: INTERVIEW TRANSCRIPT PARTICIPANT 14

Interview Number	14
Date	2021 February 17
Start Time	21:52
Duration	Min 20:00
Designation	Quantity Surveyor

Interviewer: In which stage ERP implementation currently in your company?

A. ERP fully implemented covering all the departments

B. ERP implemented in some departments

C. Not implemented even in a single department

Interviewer: What would you think about the support/ encouragement/ commitment given by top management during ERP implementation? Do you think not having a management support is a barrier for ERP implementation?

Participant: No. There was no barrier from the top management. We have a company top management. That company top management has a real requirement of this system in order to use as a monitoring system. But sometimes, the management in the project, such as project manager and people like that have some kind of knowledge gap. That knowledge gap became a barrier to the implementation. Other than that, there is no any big issue from the top management side.

Interviewer: What was the level of the support given by your co-workers/subordinates for implementing the ERP system? If they were reluctant to work with an ERP, what were the reasons that they did not like to work with an ERP?

Participant: Since this is a new experience, some people are not used to it. Some people do not have an overall understanding about the system and as a result they do not like to work in the ERP system. They feel that this is not a useful thing and they do not see the benefits of having an ERP system. So they just think whatever the way of doing their job is the same. As a result, they prefer traditional, manual paper based processes and they do not support the ERP implementation. Especially the older generation those who like to continue their paper based systems. Construction

industry is an old industry with lot of traditions. There are limited new updates introduce to the industry. Comparatively, IT industry is a daily updating industry. Technologies or concepts of the construction industry do not update frequently and old, traditional methods are continuing. Out of the total employees in the company, the number of employees who have a technical exposure is very limited. Most of them have not practiced to work with IT devices and not practiced doing smart work. They just practiced hard work. They just like to work by writing in a sheet or a book. They have not identified the advantages of having an ERP system.

Interviewer: What would you think about the support given by the ERP vendor? And the interaction with the ERP vendor? (Or IT department, if the ERP is developed by your company IT department)? Was that enough or would you think it was a barrier for ERP implementation process?

Participant: A good training is given by the company, but that is only for a limited number of employees because, the numbers of users are limited. The system can be used by all the officers in a construction company. For example, in an IT company, the leaves are also applied by a system. But due to the IT knowledge gap as well as language barrier in the construction industry it is difficult to implement the ERP system in a construction company. Because most of the systems are developed in English. I believe the Sri Lankan construction industry has a big language barrier. Most of the employees work in the company in Sinhala medium. The IT knowledge of some employees is zero. The training programs can be used only to build those skills only to a certain stage. Since the younger generation is updated with technology, they can be trained. But some people, especially the older generation cannot even train, support a lot because they are not updated with the technology. Anyway, the vendor had an enthusiasm to implement the system.

Interviewer: Was there any implementation plan with change management plan including goals and objectives you followed when implementing the ERP? If not, do not you think it is a limitation for the ERP implementation?

Participant: Actually since I was not engaged with that process, I do not have an idea.

Interviewer: Did you analyze the available and required resources (both human and technical) before implementing the ERP? If not do you think it was a barrier to the implementation process?

Participant: Yes, the resources have been analyzed. Because normally let's say an asset, those resources are counted in the system. Some computers definitely needed to start this kind of implementation, right? Our company prepared the required resources before starting the implementation. Earlier we had a punch in method to see on and off. But with before ERP implementation, company replaced them with finger print machines. Attendance was taken to the ERP.

Interviewer: What would you think about the capability of your ERP system to customize according to your company requirements without changing the company business processes? If the ERP system is not customizable, do you think it was a challenge changing the company business processes according to the ERP features?

Participant: It was an issue. I don't think it is a success in every department. The ERP process is not 100% correct. Because of some projects, we did some pilot projects. Suppose payments of subcontractors, we did a pilot project by entering the calculated measurements, even we check whether the interim bill payment applications can be done via an ERP system. We noticed that process is easier to do via an Excel sheet rather than doing it in ERP. Because carrying out those functions in the ERP system is complicated. Meaning, we had to find the links of how to do that and this and so on. We had such problems. So the easiest way was doing it in an excel sheet, example, interim payment applications, subcontractors' bills, specialized contractors' bills. But the ordering process, asset transferring, and goods receiving processes were successful in the ERP system.

Interviewer: Was there any dedicated implementation teams who responsible for the ERP implementation process and what do you think about the role played by that implementation team?

Participant: Yes, there was a responsible team, the IT department of the company. No their role was not an issue for the implementation process. They did all the installations into all individual computers and sent them to the particular user with a password. Further, their knowledge also was at a sufficient level for implementing the system.

Interviewer: Does your ERP support native languages (Sinhala or Tamil) other than English? Do not you think ERP system not supporting native languages

was a barrier for implementing since most of the employees could not understand English well?

Participant: The system supported only English and we used it only in English. Even though there was a language barrier, it was not with the younger generation. That barrier was with the older generation who has a lot of experience in construction related matters and they will get retired near future. Younger generation catch up the things very fast. For example, our store keepers, they are one of the major stakeholders in this process. They had training programs monthly. Even though the stock keeper is a little bit senior, someone working under him, carried out the ERP process as the storekeeper. But there was not an issue with young quantity surveyors and project engineers.

Interviewer: Does your ERP has ALL the functionalities and the reports that you need to carry out your day to day operations? If not available, would you think that it was a challenge for implementing the ERP system?

Participant: Yes. There was no issue with that.

Interviewer: What is your opinion on non-functional requirements of the ERP system; such as usability (how easy to understand/use the functionalities), user friendliness, reliability and security? Do you think lacking of non-functional requirements was a barrier to implement the ERP system?

Participant: It is user friendly as we use Facebook. Most of the features that I worked with easily understood without someone's guidance. However, there were some of the complicated features. But as a whole, we could do it with our general knowledge. And the system was accessed at any time. But there were some issues with the security. Even though the system was installed on our computers, security problems were there.

Interviewer: Have you found any errors in your ERP system? Usually, what was the frequency that you founding errors in your ERP system? Would it be an ERP implementation barrier?

Participant: There were errors. When we add a report, it shows the date and time we added. But if we edit it, the edited date time does not display. It shows a report as created just now. So I think it is a bug in the system.

Interviewer: Is your ERP system remotely accessible from any location, any device (such as your smart phone), at any time? If not, was that a challenge to implement the ERP system?

Participant: No. System can be accessed only from the PCs which were specifically installed the ERP system. System cannot be accessed from other devices. So it is a huge limitation for us to implement the ERP system.

Interviewer: What is your opinion regarding the speed of the internet connection you have at your company and all the construction sites? If it is poor, do you think it was a limitation in order to implement the ERP system?

Participant: Actually not enough. We used dongles. The speed of dongles is not enough for the ERP system, especially in rural areas such as Trincomalee. I worked there and that speed was not enough to work in the ERP.

Interviewer: Any other comments?

Participant: We used a VPN to communicate with the servers. Without the VPN, we cannot login to the system and it was a headache for us because most of the time we had to take the support of a technical expert for even small issues. It was not like a cloud based system and I believe that it was a huge barrier to implement the ERP.

Further, there was an access control problem. If we know the project code, even if I do not have access to that project, I can view the details of that project. Likewise, we can see the details of all the projects. I believe that system should be restricted to the information which we are not permitted to see. It is a security issue I guess.

Middle management also does not have an overall idea of what is going here with the ERP. This system is not an essential thing for them. That was the biggest issue. Middle management also worked in the system because of the top management pressure. Other than that the middle management also had not any idea or any requirement of developing, implementing this or they did not see any benefit of this. I believe the problem was with the awareness about the system and it is also a barrier to the ERP implementation.

*** End of the Interview ***