

**EVALUATION OF THE EFFECTIVENESS OF ERP
SYSTEMS USED IN CONSTRUCTION CONTRACTOR
ORGANIZATIONS IN SRI LANKA**

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Degree of Master of Science in Project Management

Department of Building Economics

University of Moratuwa
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Thesis/Dissertation submitted in partial fulfillment of the requirements
for the degree Master of Science in Project Management

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DECLARATION

I declare that this is my own work and this dissertation does not incorporate without acknowledgement any material previously submitted for a Degree or Diploma in any other University or institute of higher learning and to the best of my knowledge and belief it does not contain any material previously published or written by another person except where the acknowledgement is made in the text.

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Name of the supervisor: Ch.QS P.A.P.V.D.S. Disaratna

Signature of the supervisor:

Date:

ABSTRACT

Enterprise resource planning (ERP) systems are getting increasingly popular in Sri Lanka and throughout the world due to the inherent benefits, they provide to corporate organizations in dealing with global challenges and market rivalry.

The purpose of this study was to make recommendations to improve the effectiveness of the ERP systems utilized in Sri Lankan construction contractor organizations. To fulfill the research aim, six objectives were established.

A complete literature survey and review was conducted by referring to journal articles, publications, and e-Journals to examine past research on ERP systems. An E Questionnaire was used to collect data. Quantitative data gathered using a convenient sampling approach were statistically analyzed. Engineers, project managers, architects, quantity surveyors, and accountants were the intended audience. Respondents were chosen from contractor organizations that had used ERP systems in the past. Using the Microsoft Excel program, data were analyzed and characteristics were prioritized in terms of criticality using the Relative Importance Index (RII).

Manual data collection, manual report creation, and access limits to important modules might all be highlighted as significant constraints to ERP use in construction contractor organizations in Sri Lanka.

To reap the full benefits of an ERP system, the system should be chosen after a thorough evaluation and analysis of the products on the market, including the cost of the product, license and maintenance fees, and the flexibility in changes/modifications and troubleshooting. Furthermore, ERP vendors should have a thorough awareness of the processes and procedures involved in Sri Lankan construction projects. Furthermore, all transactions linked to construction processes/activities must be completed using the ERP system rather than manual data gathering, and the ERP system must make it easy to acquire all relevant reports. Furthermore, consulting services need to be established to aid in the selection and deployment of ERP systems in Sri Lankan construction organizations.

Key words: Enterprise Resource Planning System, Benefits, Sri Lankan construction

DEDICATION

This study is sincerely dedicated to my lovely family, my parents, my devoted wife, and my son, who have been a continual source of inspiration in my life. They have given me the motivation and discipline to undertake this work with enthusiasm and commitment. This endeavor would not be viable without their love and support.

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LIST OF ABBREVIATIONS

ERP	- Enterprise Resource Planning
RII	- Relative Importance Index
IS	- Information Systems
KM	- Knowledge Management
ES	- Enterprise Systems
MRP	- Material Requirement Planning
IT	- Information Technology
ICT	- Information and Communication Technology
PMIS	- Project Management Information System
EV	- Earned Value
BPR	- Business Process Re-engineering
CE	- Concurrent Engineering
SMEs	- Small and Medium-Sized Enterprises

1. INTRODUCTION

1.1 Background

Global rivalry and high levels of Information Technology (IT) deployments in business functions have transformed the way organizations have been managed over the last decade (Kiriwandeniya, Ruwan, Samarasinghe, Samarakoon, Kahandawarachchi & Thelijjagoda, 2013). Contracting companies have been blamed for being reluctant to benefit from experience and change because quality development is crucial for success and development in the highly competitive construction industry (Wong & Cheung, 2008). Globalization and market internationalization have raised competitive demands on businesses (Raymond & Bergeron, 2008). Hence, managers require efficient information frameworks to deal with massive data flows and manage the information generated by the firm, resulting in cost reducing, improved productivity, and service quality as business processes are becoming more complicated (Kanchana & Ranjini, 2018).

At present, both small and large companies could implement project management solutions to improve performance, competitiveness, and openness, making the most of a single framework that helps them control and monitor their projects. One of the most essential and helpful elements is the administrators' ability to work proactively on projects where resources are running low, increasing the probability of completing the job on time and profitably (Braglia & Frosolini, 2014). Further, project cost and schedule overruns may occur owing to a lack of a measurement system for monitoring and controlling project risk (Sumner, as cited in Wu, Ong, & Hsu, 2008). Moreover, inadequate resource allocation typically leads to greater pressure to multitask, resulting in a prolonged time to complete the activity (Elonen & Artto, 2003).

Information systems (IS) are created by collecting, preserving, transmitting, and controlling information tools to provide valuable decision-making information to individuals and organizations (Lee & Yu, 2012). Like an Enterprise Resource Planning

(ERP) framework, an information system is user-interfaced and meant to offer helpful information in promoting an organization's policy, processes, strategic research, and decision-making functions (Matende & Ogao, 2013). Moreover, an ERP framework is an automated enterprise computing system that enables an organization to manage the distribution of content, knowledge, and financial capital and exchange similar data and processes across the organization and generate and access information in a real-time environment (Wickramasinghe & Gunawardena, 2010). Moreover, a typical ERP system may consist of an accounting and financial module, human resources management module, manufacturing module, procurement management module, and distribution and supply chain module (Chang, Cheung, Cheng & Yeung, 2008).

ERP systems make it easy for team members to work together and give customers extremely structured applications and speedy response times. However, they might be costly and will not be affordable for most small businesses. Cloud-based systems are cost-effective for small companies since third-party workers operate them on remote servers (Braglia & Frosolini, 2014).

Furthermore, initially designed for production environments, the ERP systems have grown into a tool to serve almost all facets of business and industrial activities (Chang et al., 2008). Also, Kiriwandeniya et al., (2013) stated that the emergence and widespread adoption of ERP was a result of growing competitiveness and a greater concern for efficient procedures in performing typical company activities.

As a viable solution to the challenges identified as shortfalls in project monitoring and control, supply chain management, and judgment of project-based organizations in the construction industry, the adoption of an ERP system, in conjunction with improving the knowledge management framework at these entities, will aid them to grasp many benefits by improving productivity, minimizing costs, and acquiring real-time information needed for an effective decision-making process (Al Marri, 2014). Moreover, in addition to improving team efficiency, the framework makes it easier to make strategic decisions, retain a competitive edge and introduce successful project management (Pellerin, Perrier, Guillot & Leger, 2013). However, the ERP

implementation is sophisticated, demanding, and expensive, and it frequently surpasses the previously projected resources and, the method entails a detailed review of the organization's business processes, assessment of the best possible software product that suits the corporation's needs, execution of the chosen software, personnel training, and modification of the chosen product, including the formation of the necessary integrations (Ahmad & Pinedo, 2013). Also, the introduction of the ERP framework impacts employees at all stages of the enterprise as it slices through all operating structures. These participants vary from high management to low-level employees who use the program in their day-to-day activities (Matende & Ogao, 2013). Further, implementing a bundled ERP scheme will eventually change people's way of work (Chang et al., 2008).

The benefits of ERP include greater information exchange within the enterprise, increased strategy and decision-making process, more vital communication between business divisions resulting in higher performance, and faster response time to customer requests and inquiries. Based on these advantages, organizations can encourage customer relationship management to improve customer loyalty and satisfaction and achieve a more significant market share (Chang et al, 2008).

Furthermore, implementing an ERP System will facilitate achieving project goals while minimizing risks of cost & time overruns. In this process, the project management team/ users must input accurate data to the ERP system for analyzing correct results. The Benefits of the ERP system include streamlining and standardizing processes, eliminating unnecessary operating costs, and promoting a more robust information network by connecting the different sections of the company's information and expertise services (Chan & Mills, 2011). However, the construction methods are less organized than the production processes. Every project has its creator, is controlled by a separate project team, needs different requirements, and the considerations on success or failure and their importance to the application of ERP in the construction sector may also vary from those in the manufacturing industry (Chung, Skibniewski, Lucas & Kwak, 2008).

The ERP systems are complicated and costly, and the decision to deploy the ERP system requires a choice of methods to decide if the ERP is needed and, if installed, if it is effective (Wu & Wang, 2007). Implementation of the ERP should consider all stakeholders in the construction supply chain (Yang, Wu & Tsai, 2007). According to Matende and Ogao (2013), a significant number of ERP implementations have failed, with various possible reasons that are usually categorized as human/organizational, technological, and economical. Hence, User satisfaction is an indicator that links users' perceptions of higher levels of product or performance indicators with the success of an information system (Lee & Yu, 2012).

1.2 Research problem

Since ERP systems are difficult to implement, organizations invest significant time, effort, and energy in the implementation process with nothing to show (AboAbdo, Aldhoiena & Al-Amrib, 2019). The adoption of the ERP system varies from that of any conventional information system due to its decentralized existence, which creates drastic changes in workflow, organizational structure, and the way people perform their jobs (Matende & Ogao, 2013). Moreover, the choice of the best ERP product is critical to the ERP implementation's effectiveness (Perera, Nanayakkara & Perera, 2013). Further, Mutthusamy (2007) concluded that top management support is the key success driver during the ERP implementation process and Still, ERP coordination and composition, project management, and change management should also be given greater priority during the ERP implementation phase. The constraints in deploying ERP systems are more organizational than technological (Alcivar & Abad, 2016). Also, the ERP adoption is a big issue and a challenging endeavor for the majority of organizations (Wu, 2011).

Moreover, unlike other sectors, construction necessitates very complex data fields rarely present in off-the-shelf ERP systems from major vendors (Vlachopoulou & Manthou, 2006). Research on ERP systems in South Asia (particularly Sri Lanka) is essential, significant, and timely, as very little is known about implementing ERP in this part of the world (Wickramasinghe & Gunawardena, 2010). Various studies have been conducted all over the globe to investigate the elements that impact the effective

adoption of ERP systems. However, there have been limited studies on ERP use in Sri Lankan construction contractor organizations. The use and awareness of ERP Packages in Sri Lankan construction contractor companies are still not frequent and prominently discussed. Moreover, it offers several advantages over conventional processes. However, Past studies were carried out individually on the factors such as User resistance, Top management & Vendor support, Impact on the construction industry, and the Gap between the construction process and ERP process, which affect the successful implementation of the ERP System. However, no studies were found on evaluating the User awareness, identifying existing procedures and challenges on ERP use, and the overall effectiveness of ERP systems used in construction contractor organizations in Sri Lanka. Therefore, this study's emphasis was to evaluate the effectiveness of ERP systems used in construction contractor organizations in Sri Lanka. The findings of this research will help to use an ERP system in a Sri Lankan construction contractor organization effectively.

1.3 Aim and Objectives

1.3.1 Aim

The aim of this research is to make recommendations to improve the effectiveness of Enterprise Resource Planning (ERP) systems are used in Sri Lankan construction contractor organizations.

1.3.2 Objectives

1. Review the ERP systems used in construction contractor organizations globally.
2. Determine user awareness of the benefits of ERP systems used in Sri Lankan construction contractor organizations.
3. Identify the current ERP implementation process being utilized by Sri Lankan construction contractor organizations.
4. Examine the existing practices in Sri Lankan construction contractor organizations regarding the use of ERP systems.
5. Determine the challenges or significant constraints associated with ERP use.
6. Propose good practices to implement ERP systems in Sri Lankan construction contractor organizations.

1.4 Research Methodology

This section addresses the research methodology used to gather data to achieve research objectives. The following procedures were used to collect and analyze data for this study.

1.4.1 Literature survey and review

A comprehensive literature survey and review was carried out by referring to journal articles, publications, and e-Journals to explore past studies about ERP systems.

1.4.2 Data collection

1.4.2.1 Questionnaire Survey

An online questionnaire survey was conducted among ERP users in Sri Lankan construction contractor firms.

1.4.2.2 Sampling and sample size

Since there are not many experts familiar with ERP systems and the time limitations to compete for this research, a non-probability sampling method based on convenient sampling was used to collect responses from the ERP users in the construction contractor organizations in Sri Lanka.

1.4.3 Analysis of data

Collected quantitative data were analyzed statistically using tools in the Microsoft Excel program.

1.5 Scope and Limitations

This research was limited to identifying the procedural aspects of ERP implementation and only exploring the problematic areas or significant constraints associated with ERP use in construction contractor organizations in Sri Lanka. Data collection was limited to ERP users related to construction contractor organizations in Sri Lanka. The target population was selected within the Colombo district.

1.6 Chapter Breakdown

Chapter 01: Introduction

Presents the background to the study, problem statement, aim, and objectives, briefing of research methodology, scope and limitations of the research, and the summary of chapter breakdown.

Chapter 02: Literature review

The function of the literature review was to develop a theoretical basis for the research study. This chapter discussed ERP systems, and their advantages and disadvantages. In addition, the factors influencing ERP system implementation and ERP use in the construction sector in Sri Lanka as well as other countries were determined.

Chapter 03: Research methodology

The research methodology is described more in detail. Process of research methodology, data collection techniques, data analysis tools, and results in validation tools used was described.

Chapter 04: Data collection, analysis & research findings

This chapter discussed data collection and data analysis in detail and presented findings after a comprehensive study.

Chapter 05: Conclusions & recommendations

This chapter brings out conclusions based on research findings, recommendations based on the results related to the construction industry, and further research.

1.7 Summary

This chapter outlined the whole dissertation. In brief, the background of the problem was thoroughly explored when establishing the study's aim and objectives. The theoretical structure and research methodology were discussed briefly. Chapter two will do a systematic literature review on ERP systems.

2. LITERATURE REVIEW

2.1 Introduction

This chapter aimed to do a thorough literature review on Enterprise Resource Planning (ERP) systems. Literature findings were used to develop the research questionnaire and its variables. The history and concepts of ERP systems were addressed at the beginning. The benefits and drawbacks of ERP systems, as well as the complexities of ERP system implementation, were then addressed. Later, the ERP users, as well as the Sri Lankan context for ERP systems were discussed. Overall, this chapter established the theoretical foundation for the research's subject.

2.2. Background

When utilized successfully, an ERP system is a good strategic tool featuring an integrated set of complex techniques that may be used to govern and coordinate business processes inside a company (Shehab, Sharp, Supramaniam & Spedding, 2004). Moreover, an ERP framework is an automated enterprise computing system that enables an organization to manage the distribution of content, knowledge, and financial capital through all business functions in a shared database, exchange similar data and processes across the organization, and generate and access information in a real-time environment (Wickramasinghe & Gunawardena, 2010).

Further, the primary idea of ERP systems is information standardization and reliability, which leads to enhanced performance (Chung et al., 2008). Likewise, ERP systems are process-oriented as opposed to stand-alone, function-oriented systems (Silva, de Silva & Gunawardana, 2011). Similarly, an information system, like an ERP framework, is user-interfaced and structured to provide information that is useful for supporting the planning, processes, strategic research, and decision-making functions of an enterprise (Matende & Ogao, 2013). The four major stages of the ERP life cycle are (1) planning, (2) implementation, (3) stabilization, and (4) enhancement and the third level,

"stabilization," the implementing organization intends to reach normal activity with the new ERP system (AboAbdo et al., 2019).

The ERP system is not a Knowledge Management (KM) system, but a mechanism that can ideally minimize management effort in data acquisition, storage, and usage so that more time and imaginative resources can be spent on interpreting and contextualizing information and turning it into expertise (Chan & Mills, 2011). Moreover, Chung et al., (2008) stated that ERP systems, often known as Enterprise Systems (ES), are one of the most significant corporate management advancements to emerge in the recent decade. Because of the economic challenges due to globalization, firms are increasingly in need of more efficient overall business solutions, such as an ERP system (Wu, 2011).

2.3 Historical Background of ERP System

ERP systems, primarily designed for production environments, have grown into a tool to serve nearly all facets of corporate and industrial processes (Chang et al., 2008). Additionally, from a historical standpoint, the idea of ERP was introduced by the Material Requirements Planning (MRP) systems in the 1970s and the Manufacturing resource planning (MRPII) systems in the 1980s.

The ERP market is dominated by a few major players such as SAP, Oracle, and Microsoft Dynamics, and the ERP market is growing steadily, with the latest trend being that it is increasingly shifting towards small and medium businesses, with few new open-source ERP systems that can equal the capabilities of market-leading ERP systems (Perera et al., 2013). ERP program facilitates a knowledge channel where all of the methods, principles, and tactics we have learned through the years can potentially be implemented (Jacobs & Bendoly, 2003).

Meanwhile, ERP applications have increasingly developed as cloud-based applications, either as hybrid systems or as pure cloud-based ERP systems. Cloud-based ERP systems are based on a different technology than conventional on-site systems (Demi & Haddara, 2018). Thus, the ERP solution expanded the use of the

functions used for internal assessment, non-financial performance metrics, and profitability analysis based on market segments and services (Silva et al., 2011).

Industrial firms, as well as service-sector businesses, have a strong propensity to use ERP solutions, putting aside the common notion that ERP solutions can only be used by manufacturing companies in their activities (Mutthusamy, 2007). Also, as a viable solution to the challenges identified as shortfalls in project monitoring and control, supply chain management, and sound judgement of project-based organizations in the construction industry, the adoption of an ERP system, in conjunction with improving the knowledge management framework at these entities, will aid them in reaping many benefits by improving productivity, lowering costs, and acquiring real-time information required for effective decision-making (Al Marri, 2014).

2.4 Function of ERP System

ERP systems are regarded as cutting-edge and powerful information technology (IT) solutions that enable organizations to improve efficiency and perform more successfully (Wu, 2011). However, ERP solutions differ from other IT technologies due to socio-technical difficulties related to the difficulty of the deployment process and the diverse categories of end-users (Rajan & Baral, 2015).

Compared to other information systems, such as spreadsheets, the ERP framework is an interactive method that helps decision-making and tally an accounting kit, where administrators can easily use it to enhance internal coordination, efficiency and make a visually appealing decision-making report (Kanchana & Ranjini, 2018).

Additionally, Haddara and Moen (2017), argued that ERP systems are called cross-functional and process-centric and are structured to simplify key processes such as management, accounting, human resources, purchasing, production, and delivery.

Figure 2.1 demonstrates the basic relationships between project management software subsystems and the direction of the flow of information between the subsystems are represented by the arrows.

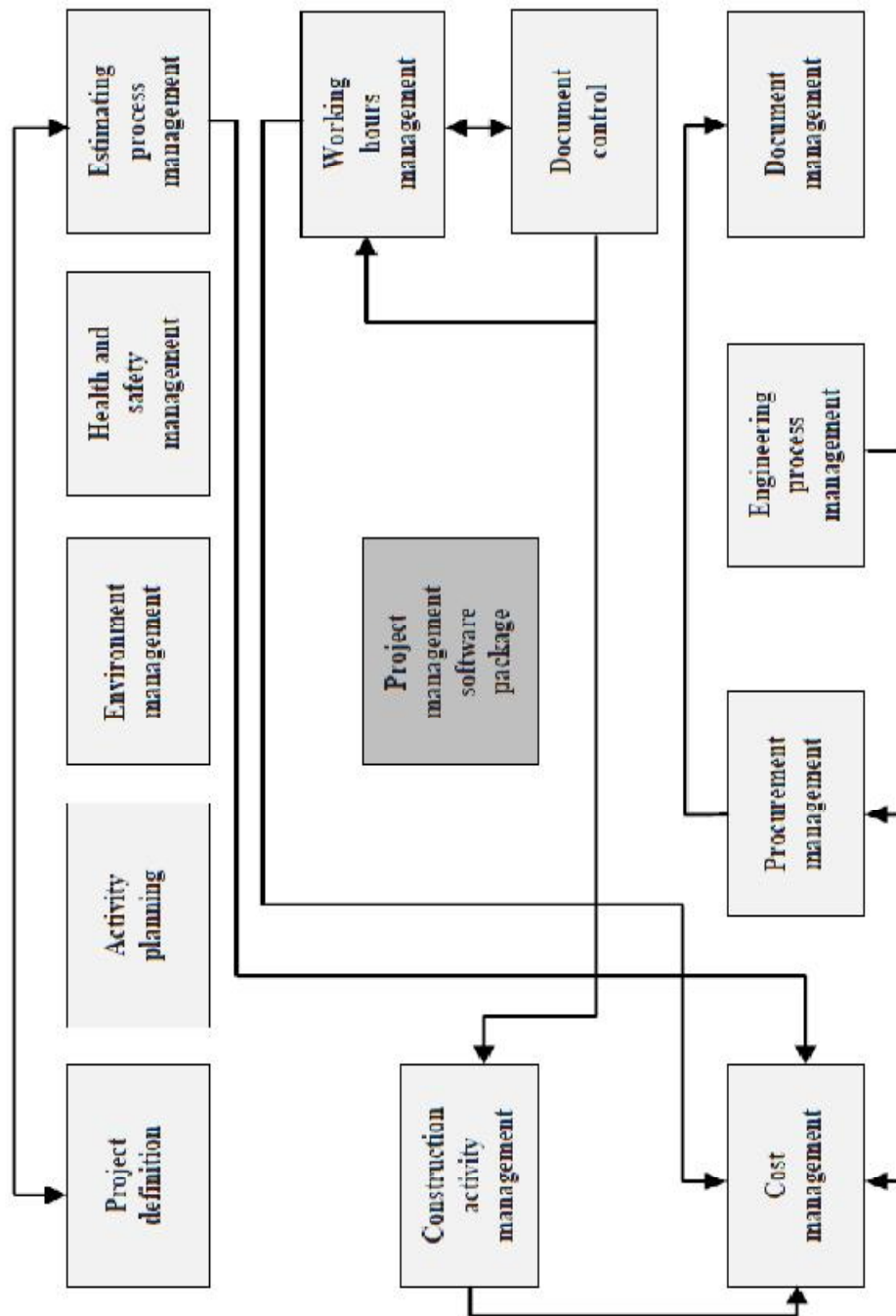


Figure 2.1: Interaction between subsystems

Source: Pellerin et al., (2013)

According to the process, the ERP framework shall deliver improved and trustworthy information to the next department in the organization (Kanchana & Ranjini, 2018). Moreover, The ERP system required the various parts of the business to connect via a common Information and Communication Technology (ICT) infrastructure and thus increase the flow of information, and the system's architecture helps the present organizational process while also allowing for potential improvements in information sharing with other important stakeholders (Chan & Mills, 2011).

Figure 2.2 depicts the function and role of the Project Management Information System (PMIS) inside the project management process as primarily subordinate to the achievement of project objectives and the implementation of critical contributions (Raymond & Bergeron, 2008).

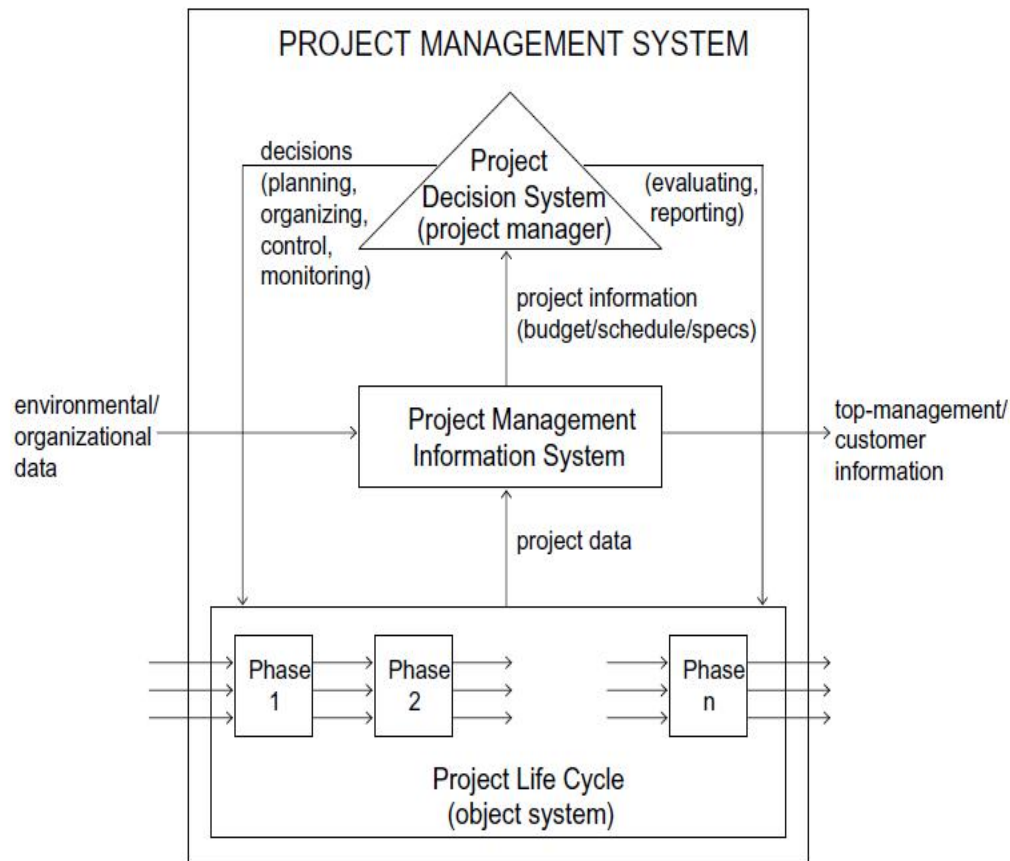


Figure 2.2: The PMIS within the project management system

Source: Raymond & Bergeron (2008).

2.5 Components in ERP system

Typical ERP system may consist, accounting and financial module, human resources management module, manufacturing module, procurement management module, distribution & supply chain module (Chang et al., 2008). Moreover, Manufacturing, Financials, Human Resources, Supply Chain Management, Projects, Customer Relationship Management, and Data Warehouse for decision making are the major areas addressed by an ERP system (Perera et al., 2013).

Hence, ERP applications can span a wide variety of functions that can be combined into a single centralized database, which offers many business modules, including Finance, Manufacturing, Distribution, and Marketing, Supply Chain, Human Resources Management, Customer Relations Management, Buying, and Inventory Control (Silva et al., 2011).

The numerous modules of the ERP include engineering data control (bill of goods, project schedule, and data center); manufacturing, procurement, and inventory (sales and delivery, inventory, and storage); material requirement planning (MRP); supply flow management, scheduling, financing, and human resources management (Shehab et al., 2004).

Figure 2.3 depicts the various key components used in an ERP framework that are integrated centrally, such as sales and distribution, finance and accounting, materials management, quality management, project management, and Human Resources.

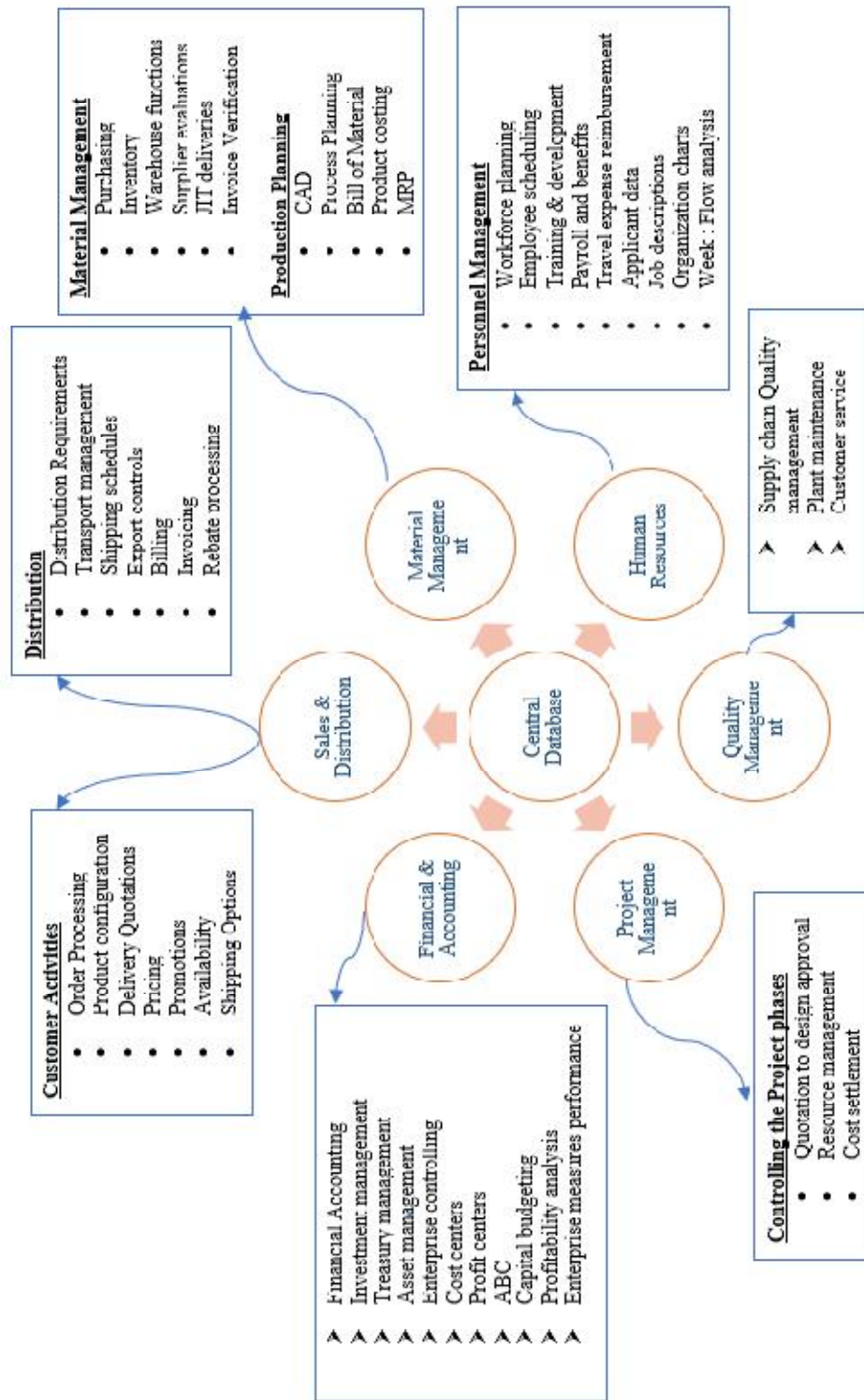


Figure 2 3: ERP System Modules

Source: Shehab et al., (2004)

2.6 Advantages of ERP Implementation

2.6.1 Standardization

The primary goal of the ERP is to standardize the procedure and incorporate the operational roles and the complexity in tasks and role interdependence are associated with standardization (Hewavitharana & Perera, 2019). Moreover, the benefits of ERP system include streamlines and standardizes processes, eliminates unnecessary operating costs, and promotes a stronger information network by connecting the different sections of the company's information and expertise services together (Chan & Mills, 2011). Furthermore, An ERP system reduces information overlap, provides real-time information, aids in standardization, and improves flow of information and interaction among individuals (Alcivar & Abad, 2016).

2.6.2 Real time data sharing

Relevant and up-to-date, correct information is important to ensure that businesses are effectively operated and meet their corporate goals (Chan & Mills, 2011). ERP systems are used to get the same up-to-date and reliable information across different activities that make the application so valuable to businesses, hence all employees in separate offices see the same information (Kanchana & Ranjini, 2018).

ERP framework enables the transfer of information within an organization by storing data in standard databases (Alcivar & Abad, 2016). The entire business could acquire an accurate view of the progress of various operations and locate timely updated information as a result of data integrity and a centralized database (Silva et al., 2011).

2.6.3 As a communication platform

ERP systems make it easy for team members to work together and consisting extremely structured applications and very quick response times (Braglia & Frosolini, 2014). Similarly, Elragal and Haddara (2013) concluded that ERP systems enable companies to minimize costs, exchange data, and information and strengthen the management of business processes by efficiently combining and managing processes and functions previously provided by legacy systems.

According to Silva et al., (2011), an ERP framework is a program that helps organizations integrate their business functions into a shared database and allows the planning and use of a broad range of organizational resources. Furthermore, greater knowledge exchange within the enterprise increased strategy, and decision-making process, stronger communication between business divisions resulting in higher efficiency and faster response time to customer requests and inquiries (Chang et al., 2008).

2.6.4 Support on decision making with improved performance

Organizations can invest in ERP systems to reap the advantages of merging all corporate structures into a single IT infrastructure and direct benefits of this transformation include the simplification of operations and the acceleration of decision-making (AboAbdo et al., 2019). Aside from increasing team efficiency, the approach encourages effective decision-making, maintaining a strategic advantage, and effective project management (Pellerin et al., 2013).

Moreover, the most significant advantage of implementing an ERP framework is the creation of a common technical network that allows for the centralization of data and, as a result, improved performance (Vlachopoulou & Manthou, 2006). Also, the ability to streamline various procedures and workflows, increase productivity and performance, minimize costs, reduced duplication of data, and boost customer loyalty can be described as benefits of the ERP framework (Silva et al., 2011).

Hence, organizations can encourage customer relationship management that improves customer loyalty and satisfaction and achieves greater market share (Chang et al., 2008).

2.6.5 Adopt industry best practices with streamlined processes

Rajapakse and Seddon (2005) argued that ERP systems have two main characteristics, namely the smooth convergence of data and processes around the enterprise and the so-called embedded best practices. Moreover, the ERP packages developed by ERP vendors are designed not only to standardize the current business processes of the

company but also to integrate some of the industry's best practices (Parthasarathy & Sharma, 2016). Similarly, stock control and optimization are some of the top rewards for companies that use ERP software, and ERP solutions help organizations optimally handle their stocks and save a lot of money (Perera et al., 2013).

2.7 Disadvantages of ERP Implementation

Implementation of the ERP is known to be difficult, complex, costly, and most frequently surpasses the initial funding and resource estimates (Ahmad & Pinedo, 2013). Consequently, the complexity is determined by the project boundaries, which comprises the range of business operations involved and the extent to which ERP system deployment alters business processes (Chung et al., 2009). When the emergence of ERP systems and the ecosystem is combined with the changing nature of company, the decision-making gets more complicated (Mutthusamy, 2007).

Organizations invest a considerable amount of time, effort, and energy in the implementation process with nothing to show for it since ERP systems are very difficult to implement. (AboAbdo et al., 2019). Rajapakse and Seddon (2005) concluded that no decrease in workers was attributed to the implementation of the ERP. Table 2.1 indicates the drawbacks in ERP systems concerning cost of implementation, functional, technical, and usability.

Table 2.1: Drawbacks of ERP systems

Cost & Implementation	• High initial cost • Only big corporations would be benefitted. • lengthy Implementation period (02-05 years) • customizing a business's process to suit the system
Functional	• Lack of functionality to handle Earned value (EV) • abnormalities in project monitoring and reporting • deficiencies in cash flow planning • limitations in reports • Unavailability of resource levelling function
Technical	• Problems with integration between ERP and non-ERP systems • Inconsistencies in data interfaces, input, and management by the ERP system. • difficult to manage third party documents
Usability	• The learning curve is very steep • Less user-friendliness interface • Input data are not always in logical • Unavailability of online help. • Difficult to understand

Source: Shehab et al., (2004)

2.8 Implementation of ERP system

Adoption of an ERP software is and remains a vital field of concern to researchers. The adoption of the ERP system varies from that of any conventional information system due to its decentralized existence, which creates drastic changes in workflow, organizational structure, and the way people perform their jobs (Matende & Ogao, 2013).

The mechanism includes a detailed review of the existing business processes in the organization, evaluation of the best possible software solution that fulfills the expectations of the organization, implementation of the chosen systems, training of employees and configure the chosen software solutions, along with the creation of the interfaces where necessary (Ahmad & Pinedo, 2013). Hence the ERP implementation is a massive undertaking that necessitates a significant improvement in procedures, as well as a transition in corporate culture, to consolidate the firm's information exchange and business processes (Vlachopoulou & Manthou, 2006).

Alcivar and Abad (2016) concluded that the training on ERP system has a beneficial impact on user awareness and satisfaction by introducing gamification elements which is the use of game mechanics and game creation methods in non-gaming contexts. Several experiments demonstrate that gamified systems improve user interaction and efficiency.

Although ERP system vendors aim to incorporate all of a company's processes, their packages often lack key features, and the change from a conventional system to an ERP necessitates re-engineering of certain business processes at the organizational level (AboAbdo et al., 2019). According to an analysis of the achievements on the websites of three prominent ERP providers (www.sap.com, www.oracle.com, and www.peoplesoft.com), less than 7% of ERP deployments globally have occurred in emerging Asian nations (Rajapakse & Seddon, 2005).

2.9 Factors Affecting ERP Implementation

The adaptability of various systems is crucial to the success of ERP system installation (Chung et al., 2009). Moreover, if the ERP deployment process is not properly conducted, it may result in significant cost and time overruns (Perera et al., 2013). According to Perera and Costa (2008), the issue is, in the first place, the incorrect selection of solutions without adequate consideration of needs and programs. Also stated that, if the organization makes the correct preference in choosing the best suitable ERP solution, most implementation and post-implementation conflicts can be reduced.

When choosing between proprietary and open-source ERP systems, open-source systems rate higher on sustainability for a developing country like Sri Lanka due to the absence of commercial ERP vendors' high license costs (Perera et al., 2013). According to Matende and Ogao (2013), a significant number of ERP implementations have failed, with a variety of possible reasons for these failures provided. As per the literature, such failures will usually be categorized as human/organizational, technological, and economic. Table 2.2 brings the factors affecting ERP implementations which were concluded by various researchers.

Table 2.2: Factors Influencing ERP Deployments as Observed by Various Researchers

Researcher	Factors Influencing ERP Deployments
Somers and Nelson (2001)	Support from top management, project team expertise, Cooperation between departments, Clearly defined aims and objectives, Inter-departmental communication, project management Expectation management, Champion of the project, Vendor assistance, Package selection that is astute, Data conversion and analysis Specialized resources, The steering committee User education, Business Process Reengineering (BPR), Limited customization, and Education on New Business Processes Architecture options, Management of Change, Vendor collaboration, vendor tools, and the use of specialists.
Nah, Lau, & Kuang (2001)	ERP collaboration and structure, Support from top management, Business strategy and vision, Interaction that works, Management of a project, Project champion, Corporate and aging systems that are appropriate, Program and culture of change management, BPR and minimal customization Software creation, testing, and troubleshooting Performance monitoring and assessment.
Huang, Chang, Li & Lin (2004)	An absence of management support to the project, Ineffective user interaction, Inadequate user training, unable to obtain user help, Inadequate project management methods, attempting to construct bridges to older programs, Disagreements between user departments, A project team member's composition, if you don't change your business processes, you'll be left in the dust. Uncertainty/misinterpretation of shifting needs.
Wong, Scarbrough, Chau, & Davison (2005)	ERP system incompatibility, Project team members have a high turnover rate. Excessive emphasis on personalization, Poor consultant effectiveness, inadequate IT infrastructure, ineffective knowledge transfer, and ineffective project management, BPR is of poor quality, as is testing. Inadequate top-level management support the project's timeline is too constrained. From the users' point of view, there is a hazy understanding of the nature and application of ERP systems. Top management has unrealistic expectations for the ERP system. Change aversion among users.
Upadhyay, Jahanyan, & Dan (2011)	Cooperation from top management, Proficiency of the project team on Management of projects, User education and training Consultants from outside sources, Package selection that is appropriate, Knowledge and assistance from the vendor's employees Clearly defined aims and objectives, Participation and involvement of users Champion of the project, The project's cost, Change management that works, Project composition and management, Collaboration inside an organization, Management of knowledge transfer, Minimal modification.

Source: Jayawickrama & Yapa (2013)

Furthermore, the implicit complexities of ERP implementation, problems with outside vendors, insufficient training, process risk, and process constraints, and cooperate culture are some of the key factors that impact ERP implementation failures (Kiriwandeniya et al., 2013). Moreover, vendor support is critical when addressing problems related to the ERP software, system and hardware enhancements and new releases, licensing, user training, customization, fast access, and support from the service provider are crucial for the expanded use of ERP in management accounting practices (Silva et al., 2011). Also, the choice of the best ERP product is critical to the ERP implementation's effectiveness (Perera et al., 2013).

Mutthusamy (2007) concluded that top management support is obviously the key success driver found during the implementation process of the ERP, but ERP coordination and composition, project management, and change management should also be given greater priority during the phase of the ERP implementation. Further, Haddara and Moen (2017), concluded that user resistance is a major element in why many ERP initiatives fail or experience difficulties. Furthermore, many companies make the mistake of expecting to enjoy the gains before finishing the whole implementation process, assuming that the "go live" stage is the final destination or milestone, which is not the case (AboAbdo et al., 2019).

2.10 ERP Solution for Construction Industry

2.10.1 Nature of construction industry

Traditional knowledge processing in the construction sector has been questioned for a long time and more apparent disadvantages include "paper-based results" and "non-real-time approach" (Chan & Mills, 2011). The lack of suitable infrastructure for smooth project team interactions stems from the construction industry's diversity (Kimmance, Anumba, Bouchlaghem & Baldwin, 2004). Project cost and schedule overruns may occur owing to a lack of a measurement system for monitoring and controlling project risk (Sumner, as cited in Wu, Ong, & Hsu, 2008). Moreover, inappropriate resource allocation also increases the stress on multitask, resulting in project latency (Elonen & Artto, 2003) As a result, in concurrent engineering, where

interconnection is even more crucial, an error-free information distribution network (getting the right information to the right location in the right format at the right time) is becoming a necessity (Kimmance et al., 2004).

Significant changes in the complex corporate world have made it impossible to thrive in manual paper works. Isolated programs do not enable contact across the enterprise, which is critical for development and sustainability (Silva et al., 2011). As a result, construction companies have begun to implement computerized IT solutions such as ERP packages to better manage their many business operations, particularly those pertaining to accounting procedures and activities (Chung et al., 2009).

2.10.2 Adaptability of ERP solution for the construction organization

Quality of information is highly critical for decision-making in the construction industry and Project managers facing difficulties to fulfill these criteria due to low-quality or outdated information, hence successful application of project management requires reliable, appropriate, and timely updated information (Chan & Mills, 2011). Moreover, construction projects are unique perspectives from one setting to another depending on the variables of the scope, time, cost, and quality (Kanchana & Ranjini, 2018).

Therefore, various computer programs assist in building maintenance activities at each level of the process and the adoption of the concepts of Concurrent Engineering (CE) in construction is the need for an efficient communication system that promotes smooth cooperation between the different characters involved in construction projects (Kimmance et al., 2004). Businesses have moved toward computerization because of technical advancements, and ERP has captured the interest of the construction industry during the previous few decades (Hewavitharana & Perera, 2019).

An ERP system is a business information management solution that allows construction firms to handle capital projects more quickly and reliably during the project life cycle (AboAbdo et al., 2019). Furthermore, the author stated that the ERP's standardization and accuracy would boost project analysis and tracking, and ERP gives

the project management team resources and functionalities to streamline project data and reports during the project life cycle. Moreover, organizations who have adopted ERP have seen a considerable increase in the success rate of their Projects (Hewawitharana et al., 2019). One of the most effective and vital factors is the potential for the supervisors involved to work proactively on projects where resources are behind the plan, increasing the probability that the project can be executed on time and profitably (Braglia & Frosolini, 2014). Hence, “ERP system can be considered as an intangible asset to a construction company” (Hewawitharana et al., 2019).

2.10.3 Challenges on ERP implementation in a construction organization

ERP brings many opportunities to the construction industry, though construction firms are also reluctant to implement ERP solutions. Also, this might be attributable to long-standing informal procedures in the construction sector that do not adhere to the defined rules in ERP systems (Hewavitharana & Perera, 2019). However, construction methods are less organized than production processes. Further, every project has its creator, is controlled by a separate project team, needs different requirements, etc., and the considerations on Success or failure and their importance to the application of ERP in the construction sector may also vary from those in the manufacturing sector (Chung et al., 2008).

The challenges faced during ERP system implementation are more organizational in nature than technology in nature (Alcivar & Abad, 2016). ERP deployment is a critical concern and a challenging undertaking for most businesses (Wu, 2011). Moreover, construction, unlike other sectors, necessitates very complex data fields that are rarely present in off-the-shelf ERP systems from major vendors (Vlachopoulou & Manthou, 2006). Further, the difficulty depends on the scale of the project, which includes the number of business processes affected and the degree to which the introduction of ERP systems alters business processes (Kanchana & Ranjini, 2018). The complexity of the construction industry, along with the lack of sufficient customized ERP systems tailored to the industry's specific needs, makes evaluating and selecting an acceptable ERP system difficult (Vlachopoulou & Manthou, 2006).

2.10.4 Current state of ERP use in the construction industry

Since the construction business is so diversified, with so many specializations and so many disparities in firm size, connecting projects is a significant difficulty, and ERP system implementation in construction companies lags well behind that of other industries (Hewawitharana et al., 2019). Meanwhile, major construction firms are starting to see the benefits of ERP solutions, but they are typically hesitant to engage in and use these systems owing to the significant costs and risks involved with ERP system adoption (Chung et al, 2008).

However, both small and large companies can implement project management solutions to improve performance, competitiveness, and accountability, making the most of a single framework that helps them to control and monitor their projects (Braglia & Frosolini, 2014). Presently, Major construction firms have begun to implement ERP systems as a computerized IT solution to effectively manage the many company operations and services, particularly those related to project financial reporting procedures and processes (Chung et al., 2008).

2.11 ERP Users

2.11.1 Type of ERP users

Implementation of ERP systems is being called People-oriented solutions since all of the key obstacles are linked to people (Kumara, Gunawardana & Halwatura, 2013). There are about six or more different types of professionals involved in a typical Project. Moreover, Users' involvement in the adoption of ERP systems differs from that of traditional data analysis and management of information systems. The use of the ERP system would enhance the way individuals' function inside the firm (Matende & Ogao, 2013).

Moreover, implementation of a bundled ERP scheme will eventually change the way people work (Chang et al., 2008). Further, Matende and Ogao (2013) argued that the adoption of the ERP framework impacts employees at all stages of the enterprise as it

spreads through all operating structures, which may vary from high management to low-level employees who use the ERP solution in their day-to-day activities.

Many organizations use the selection and deployment of new ERP solutions as a catalyst for global business process re-engineering, and if this is the company's goal, adequate knowledge, and training of users on the new business processes, rather than simply implementing a new computer system, is a key success factor (Vlachopoulou & Manthou, 2006). Table 2.3 Summarizes the attributes of ERP Users at various stages of assimilation.

Table 2. 3: ERP user characteristics at various stages of adoption

ERP user type	Characteristics
Transaction users	• Use ERP software for everyday tasks that they have been taught to accomplish. • Have little knowledge of, and/or interest in, the underlying workings of ERP systems. • ERP is simply another software program they utilize every day to accomplish their profession. • Unconcerned with how the ERP system performs across the organization or how it may be utilized in novel or creative ways.
Power users	• Have a thorough grasp of how the system operates and how its many components interact with one another. • Is capable of resolving routine technical issues for other ERP end-users. • Can generate haphazard analytical reports to fulfill the needs of management. • Can give comments about how to enhance the ERP functionalities based on difficulties discovered.
VIP users	• Have a thorough understanding of both the ERP software and the business operations, as well as how they interact. • Capable of advising and enabling system and process improvement modifications. • Participated in the ERP system's early installation phase. • Can begin new ERP projects for the business as business processes change.

Source: (Liu, Feng, Hu & Huang, 2011)

2.11.2 User Resistance

User resistance cannot inherently be viewed as a harmful attribute since it can provide crucial input to consultants. Issues that have not been fixed can now be tackled and management can understand why employees are avoiding the ERP (Haddara & Moen, 2017). Moreover, employee frustration and disappointment may arise because of the long-term implementation stage of ERP systems (AboAbdo et al., 2019). In the ERP setting, users always have no alternative but to follow the process and there are a variety of excuses to refuse. Sources of user resistance have been identified within the perspective of the user, system, and interaction-oriented approaches, such as gender, beliefs, user interface, efficiency, usability, and interaction between users and the system (Haddara & Moen, 2017).

The demographics, morality, interface design, trustworthiness, dependability, and the relationship between people and system have all been identified as causes of user resistance from the standpoints of people, system, and interaction-oriented views (Haddara & Moen, 2017).

2.11.3 User training

The advantages of ERP implementation may be lost if users are not well trained (Alcivar & Abad, 2016). There has been few research focus on individual or user-level ERP software deployment (Matende & Ogao, 2013). According to Wu (2011), fewer research on ERP operation gives adequate focus to ERP users' reported benefits. Further, giving proper training can change the negative attitudes of the user when an organization attempt to adopt a new system (Perera et al., 2013). According to Kumara et al., (2013) when companies try to introduce modern technology, it is noticed that a lot of user attitudes are hostile, increasing the failure rate of ERP system implementation. By providing enough training, users' behaviors may be changed.

Moreover, Hewawitharana et al., (2019) discovered that the expenses for user trainings assigned by construction firms are far less than what is required. Eventually, training of a large number of employees has become a challenge, and It was not only a matter

of user training but rather of re-training the entire population who were supposed to work in a segregated environment and who were now expected to work in an interconnected working environment (Rajapakse & Seddon, 2005).

2.12 Sri Lankan Context on ERP Systems

2.12.1 Evolution of ERP systems in Sri Lanka

According to Mutthusamy (2007) Sri Lanka switched to ERP technology at the end of the 1990s, but research points out that the failures at the beginning are minimal compared to many of the developed countries in their early stages. Moreover, Rajapakse and Seddon (2005) concluded that there is very little knowledge of ERP solutions in Sri Lanka. Eventually, Sri Lankan companies adopt ERP programs to achieve requirements that are not specifically unique to the industry, but that is significant and similar to most organizations.

Few ERP products were available on the Sri Lankan market and a few local entities have implemented ERP solutions with an adequate number of modules contributing to an interconnected ecosystem and some success (Rajapaksa & Seddon, 2005). And several of the companies said they had an ERP framework although they just had a financial module. The financial module is Sri Lanka's most famous module (Mutthusamy, 2007). Meanwhile, most Sri Lankan organizations have struggled to thrive in the long run, despite a growth in the implementation of ERP systems (Kiriwandeniya et al., 2013). Despite these risks, firms are lured to ERP, and demand for ERP is growing quickly in Sri Lanka and across the globe. Though Sri Lanka is now falling behind in terms of new technology, the pace of technology transfer is quite high. SAP is the most popular vendor in Sri Lanka, and its numbers are fairly close to those of the rest of the planet (Mutthusamy, 2007).

Despite a significant difference in the adoption of ERP systems as opposed to the rest of the world, the pace of ERP adoption within the country has significantly improved (Kiriwandeniya et al., 2013). Moreover, ERP systems are also becoming a trend in Sri Lanka and organizations strive to invest heavily in ERP solutions that pursue the

rewards offered while achieving corporate excellence (Jayawickrama & Yapa, 2013). Further, ERP systems are increasingly being used in Sri Lanka's corporate sector (Kiriwandeniya et al., 2013).

In today's complex technical context, information systems (IS) are seen as a significant challenge for Sri Lankan businesses. Moreover, besides many of the growing companies are moving towards ERP structures to merge their cross-functional business divisions which is important for them to be stable and successful in the sector (Silva et al., 2011). As a developing nation, the ERP's long-term viability is crucial for sustained ERP adoption, and the technical elements must be compatible with Sri Lanka's technological infrastructure (Perera et al., 2013).

2.12.2 Challenges on ERP implementation in Sri Lanka

Sri Lankan companies do not prefer merely to assume that they can handle the project effectively by relying on future gains but use a more systematic approach in the decision to follow the ERP (Mutthusamy, 2007). While ERP systems offer many advantages, many businesses have experienced challenges during the implementation phase due to various myopia within the organization (Senadheera, Wadugedara, Chandrasekara, Yasiharan, Suwadika, Sivaroshan, & Hennakgedara, 2018).

Since Sri Lanka is a developing nation, many in the construction sector are resistant to ERP deployment (Hewavitharana & Perera, 2019). Similarly, user intervention, training and education, user wants stewardship, inter - departmental collaboration, ERP team cohesion and framework, software development, troubleshooting, implementation, project champion, business process re-engineering and customization change management program and culture, and efficient communication differ considerably among adaptive and maladaptive ERP adoptions in Sri Lanka (Wickramasinghe & Gunawardena, 2010).

Several ERP implementations in the Sri Lankan government sector have collapsed due to the "people element," or, in other words, user resistance (Perera et al., 2013). However, firms are increasingly encountering less resistance from employees about

ERP system deployment and a greater willingness to learn advanced skills (Silva et al., 2011). According to Hewavitharana and Perera (2019) Top Management (Chief Executive Officer / Director, General Manager, Project Manager, Engineer, Technical Manager), Technical Officer / IT Officer, Quantity Surveyor, Data Entry Operator, Stock Keeper described as individuals using ERP, such as contractors, subcontractors, and employees related to the construction industry in Sri Lanka.

2.12.3 Consultation services for ERP adoption in Sri Lanka

Consulting services are internationally available to guide the selection of ERP systems and issues associated with the implementation process. But the availability of such consulting services in Sri Lanka is very limited and very costly (Perera & Costa, 2008). Meanwhile, both consumers and service providers believe that senior management commitment is important in Sri Lankan ERP installations (Jayawickrama & Yapa, 2013). Moreover, the consultants are aware that, many problems arise in the client's ERP system selection process, with the root causes being the client's lack of understanding of ERP package functionality, assessment processes, project scope, and so on (Jayawickrama & Yapa, 2013). However, the authors concluded that clients are dissatisfied with the competency of consultants in ERP solution providers; in other words, consultant competency in Sri Lanka is lacking.

2.13 Summary

A thorough literature review was undertaken, and all relevant details about the research's topic were examined. It was an acquisition of knowledge of other authors who have researched ERP systems.

Despite the facts that researches have provided various definitions about the ERP systems, it was determined that “The ERP framework is an automated enterprise computing system that enables an organization to manage the distribution of content, knowledge, and financial capital through all business functions in a shared database, exchange similar data and processes across the organization, and generate and access information in a real-time environment” as the working definition which incorporates majority of the preceding authors views.

The historical background, the definition of the ERP application, the mechanism, and the components of the ERP software were all explored at the outset of this chapter. The second half of the discussion focused on the benefits and drawbacks of ERP solutions, as well as the factors that influencing ERP adoption. Later, the ERP system used in the construction industry, ERP users, and the Sri Lankan context on ERP systems were discussed. Moreover, this chapter was used as the basis for developing the research questionnaire.

3. RESEARCH METHODOLOGY

3.1 Introduction

The previous chapter presented the literature on the research area. This chapter aims to present the study's research methods and show how data collection and analysis can strengthen the literature findings. It further introduces the concepts of research methods and their analysis processes in conjunction with the feedback obtained concerning the characteristics of the respondents. It also explains the methods underpinning this study and explains the research approach chosen.

Moreover, Melnikovas (2018) stated that the methodology chapter starts with the interpretation of the basic concept, then moves on to the selection of initiatives, methods, and methodologies, as well as the formation of timeframes, all of which ultimately led to the research methodology and the leading mechanisms and practices for collecting and analyzing data. According to Kothari (2004) the purpose of research is to identify solutions to issues via the application of scientific procedures. The author also stated that research is an art of scientific study that is an academic endeavor, and as such, the concept must be used in a technical meaning.

Furthermore, the research seeks to discover a previously unknown knowledge (Peffer, Tuunanen, Rothenberger, & Chatterjee, 2007). Research methodology is a broad research approach that defines how research can be conducted and involves beliefs and ethical principles that shape how research problems are interpreted and how research methods are chosen (Melnikovas, 2018).

3.2 Research Approach

Research approaches are plans and the procedures for research that the steps from board assumptions to detailed data collection methods, analysis, and interpretation (Creswell, 2014). Moreover, a research strategy is a broad approach that assists the

researcher in choosing main data collecting techniques or groups of procedures to answer the research question and fulfill the research objectives (Melnikovas, 2018).

According to Creswell (2014) qualitative, quantitative, and mixed approaches give the research study guidance. Moreover, as a research approach that sees qualitative and quantitative research methods as complementary strategies that help researchers holistically answer the research questions through different means (Chawinga & Zinn, 2020). The research approach was to gather and analyze quantitative data while making reasonable assumptions; the Literature review used as a basis for the preparation of the Research questionnaire.

3.2.1 Quantitative approach

Quantitative research is concerned with the quantification and analysis of input variables to derive conclusions. Moreover, it uses statistical techniques to evaluate numerical data in order to answer queries like "who, how much, when, when, whom, how many, and how" and, it may also refer to gathering numerical data to highlight a problem or phenomenon (Apuke, 2017).

Quantitative analysis is a way for evaluating objective assumptions by investigating the interplay of factors. These parameters will then be computed with equipment, yielding numerical data that may be analyzed statistically (Creswell, 2014). Furthermore, "Quantitative methods can be categorized into survey research, correlational research, experimental research, and casual-comparative research" (Apuke, 2017). Therefore, quantitative analysis may also be exploratory, in which interactions, interpretations, and traits of topics are discovered, leading to the development of new theories and the definition of new problems. Instead of specific assumptions, research questionnaires are used (Holton & Burnett, 2005).

A quantitative research approach was used to discover existing practices and the problematic areas on ERP use in construction contractor companies in Sri Lanka. The data collecting process also includes collecting numerical information via questionnaires so that the final database represents quantitative information. Relevant

ERP System literature aided in narrowing the area of research and identifying concepts, frameworks, models, and findings by previous researchers.

3.3 Research Process

This research aimed to make recommendations to improve the effectiveness of Enterprise Resource Planning (ERP) systems are used in Sri Lankan construction contractor organizations. Since researchers use various methods dictated by conventional and contemporary methodological philosophies, the data content, scale, and structure are likely to differ (Chawinga & Zinn, 2020). A survey research method was applied by collecting quantitative data from a significant sample to obtain results statistically to achieve the aim of this research. To avoid errors and to plan a proper guideline, a research process was thus created. The research process phases included initial study, literature review, data collection, data analysis & conclusion. Subsequent sections illustrate the whole research process.

3.3.1 Initial study

A background study was conducted by referring to journal articles, websites, and books. Based on the research gap, aim, objectives, scope limitations were formulated. The research problems and goals must be stated together, and they transform a research problem into one that can be investigated. Moreover, one way to solve a research problem is to develop a collection of research goals that can be used to investigate, characterize, consider, justify, forecast, alter, analyze, or measure social phenomena (Blaikie, 2003).

3.3.2 Literature review

For several years, the importance of scientific evidence concluded after a manuscript was submitted for publishing – it was seen as a by-product of the whole research process, with a manuscript or reported results known as the main product (Chawinga & Zinn, 2020). The researcher would specify his research issue in a meaningful context after discovering what data and other resources are accessible for organizational purposes due to the literature review (Kothari, 2004). Thus, a comprehensive literature review was carried out using published journal articles,

books, and websites to gather information on ERP systems, benefits, and drawbacks. Furthermore, the factors affecting ERP system implementation, ERP use in the construction industry in Sri Lanka as well as the other countries were identified.

3.3.3 Data collection

Data collection is the core activity in a research study. The data collection method of this research is collecting quantitative data through a questionnaire survey. Moreover, data collection is the process of gathering and evaluating data on certain variables in an organized context to answer important questions and evaluate outcomes (Data collection - Wikipedia, 2021, Para.1).

Questionnaire Survey

A questionnaire survey shall be conducted, which will be with closed-ended questions to validate the literature findings. The questions shall be included in a Likert scale to gather information with a more improved response rate and to receive quantitative data. According to Kothari (2004), on a Likert scale, respondents were asked to rate their agreement or disapproval with any of the claims on a scale of one to five (though three or seven can also be used).

A detailed structured questionnaire is developed with closed-ended questions comprising two main sections to collect quantitative data. The first section allowed for general information about the respondent, such as his or her name, organization, title, and work experience. The following section was the central part of the questionnaire, which includes structured questions covering the research objectives to gather information. Respondents were given a preference of five pre-determined answers on a five-point (1-5) Likert scale, with a neutral point included. It helped respondents to convey how important a specific statement is to them.

Sampling Method

The method for choosing a sample, also known as the sample design, must be decided by the researcher. Kothari (2004) stated that a sampling strategy is a pre-

scheduled process for selecting a sample from a given population that is determined prior to data collection.

Engineers, project managers, architects, and quantity surveyors, accountants were the target population. Respondents were drawn from contractor organizations that had worked with Enterprise resource planning (ERP) tools. Convenient sampling was used to collect responses from experts of the construction contractor organizations in Sri Lanka. This approach was used to analyze the survey areas better to simplify the population with the available options of the sample population since there are not many experts familiar with them.

Convenient sampling is a type of nonprobability or nonrandom sampling in which people of the target population meet particular criteria, such as ease of access, geographic closeness, availability at a given time, or desire to participate, and are included in the study (Etikan, Musa & Alkassim, 2016). Furthermore, the author claimed that, while convenience sampling may be utilized in both qualitative and quantitative research, it is most typically used in quantitative studies.

3.4 Data Analysis

Data analysis aimed to gather usable and helpful information to reach particular findings and suggestions. Researchers are often concerned with extensive data collection, faster retrieval as required, and data processing using different techniques. Computers are best suited for data analysis (Kothari, 2004).

The method of statistical data processing was used to review and interpret data in this study. Following the completion of data collection through the questioner survey, data were screened, edited, and entered before carrying out the data analysis.

Therefore, the relevance levels of each attribute were analyzed, and the attributes were ranked in terms of criticality using the Relative Importance Index (RII) using the Microsoft Excel application.

3.4.1 Relative importance index

Relative significance analyses can help understand each variable's specific role in a multiple regression equation plays. Importantly, these analyses are more reliable than generic regression coefficients or simplistic correlations in revealing the underlying effect of a given indicator (Tonidandel & LeBreton, 2011).

The below formula was used in the computation of the Relative Importance Index (RII),

$$RII = \Sigma W / (A * N)$$

W - The respondents' weightings for each factor (ranging from 1 to 5)

A - Greatest weight on Likert scale

N - Number of Respondents

The data analysis observations and conclusions were presented using bar charts and pie charts as a graphic means of describing data so that the findings could be quickly understood.

3.5 Chapter Summary

The research technique of a dissertation or thesis is an important component that helps to ensure consistency across resources, processes, and basic principles (Melnikovas, 2018). Moreover, any approach or technique used in the conduct of research can be defined as a research method (Kothari, 2004). It also acts as a framework for the researcher as well as the reader. Furthermore, it allows a thorough comprehension of the method of achieving the research aim.

This chapter describes the various steps that the researcher takes in researching his research problem and the reasoning that underpins them. As data collection methods and analysis methods were outlined, a questionnaire survey would be performed through a convenient sampling method to achieve the goals and adequately complete the research's aim.

4. DATA COLLECTION, ANALYSIS & RESEARCH FINDINGS**4.1 Introduction**

Data analysis is the chapter that follows all the data that has been captured using the data collection and analysis methods described in chapter three. Before beginning the data analysis, it is critical that the accuracy of the data obtained be confirmed. The most crucial aspect is that data be rigorously evaluated and presented in a relevant manner. This chapter offers the data that addressed the study's research objectives. Moreover, this section describes the sample, response rate, quantitative data analysis, and the interpretation of findings. Microsoft Excel was used to do the calculation. Furthermore, data analysis results and insights are graphically shown using bar charts and pie charts.

The aim of this research is to make recommendations to improve the effectiveness of Enterprise Resource Planning (ERP) systems are used in Sri Lankan construction contractor organizations. Therefore, six research objectives were outlined to achieve this aim:

- Review the ERP systems used in construction contractor organizations globally.
- Determine user awareness on the benefits of ERP systems used in Sri Lankan construction contractor organizations.
- Identify the current ERP implementation process being utilized by Sri Lankan construction contractor organizations.
- Examine the existing practices in Sri Lankan construction organizations regarding the use of ERP systems.
- Determine the challenges or significant constraints associated with ERP use.
- Propose good practices to implement ERP system in Sri Lankan construction contractor organizations

Furthermore, based on the literature review findings, a structured questionnaire was created to fulfill the research objectives.

The research was conducted through a quantitative approach. A structured questionnaire was created for this purpose. The structured questionnaire survey included a five-point (1-5) Likert scale. Respondents' significance levels for each component were assessed using the relative importance index (RII), detailed in the research methodology chapter. The RII value was expressed as a percentage, making it simple to grasp. Furthermore, questions that did not include the Likert scale were evaluated to acquire additional data and make interpretations more relevant.

4.2 Findings on Demographic Questions

4.2.1 Response Rate & Composition

After sending 95 questionnaires to selected construction professionals representing project managers, engineers, quantity surveyors, accounting/finance, and human resource administration, 37 responses were obtained. Only 30 of the 37 respondents currently use an ERP system in their organization. Table 4.1 outline the number of questionnaires issued and received by construction professionals, as well as the response rate for each professional category.

Table 4. 1: Summary of respondents to the questionnaire

Professional Category	Number of Questionnaires distributed	Responses Received	Rate of Response
Accountant/ Finance	15	9	60%
Project Manager	13	7	54%
Engineer	22	7	32%
Quantity Surveyor	38	11	29%
HR/ Admin	7	3	43%
Total	95	37	39%

Accounting/ Finance professionals had the highest response rate of 60%, while Quantity Surveyors had the lowest response rate of 29%. Furthermore, the overall response rate is 39%. The reason might be the Covid 19 global pandemic crisis. Figure 4.1 depicts the status of the 37 respondents and 58 non-respondents out of a total of 95 questionnaires distributed among professionals.

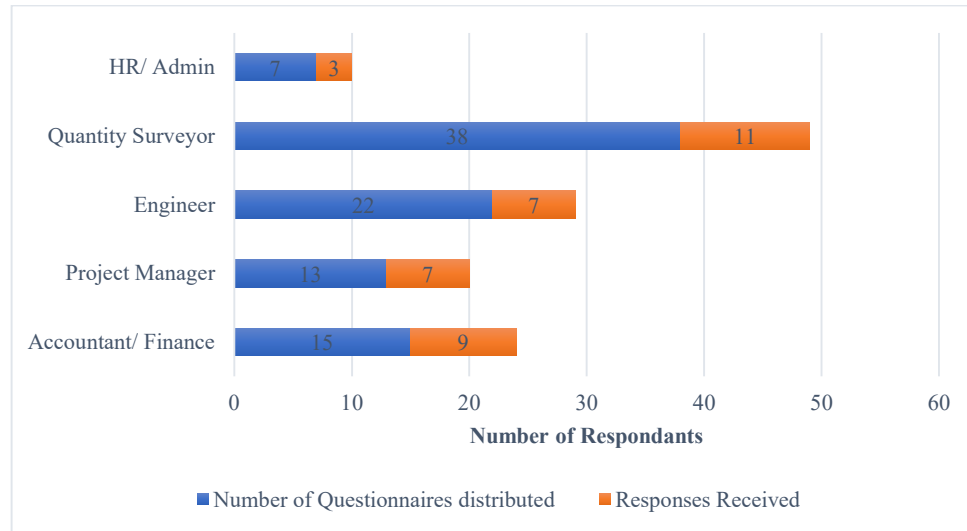


Figure 4. 1: Status of respondents & non-respondents

The composition of respondents by professional classification is demonstrated in figure 4.2. Furthermore, most respondents (30%) were quantity surveyors, followed by 24% from finance/accounting, project managers, and engineers, each with 19 % involvement, while the HR/Admin area had the lowest participation (8%) categories.

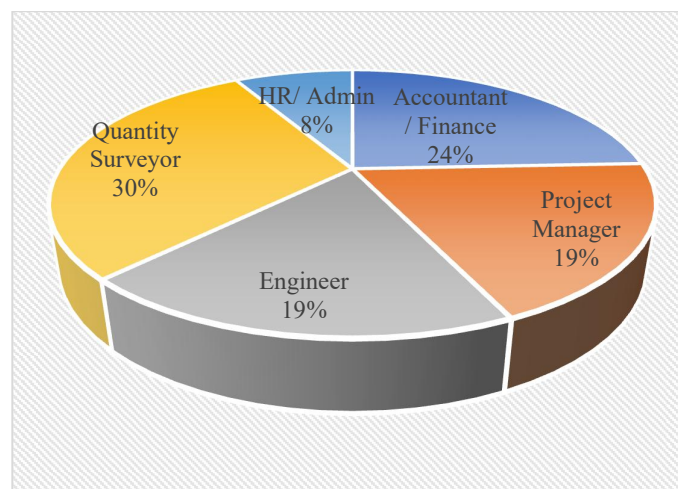


Figure 4. 2: Composition of respondents

4.2.2 Industry Experience of the Respondents

The working experience of the sample respondents are divided into four primary categories. Figure 4.3 highlights the respondents' industry experience. The majority of respondents had over ten years of industry experience, with only 8% having fewer than three years.

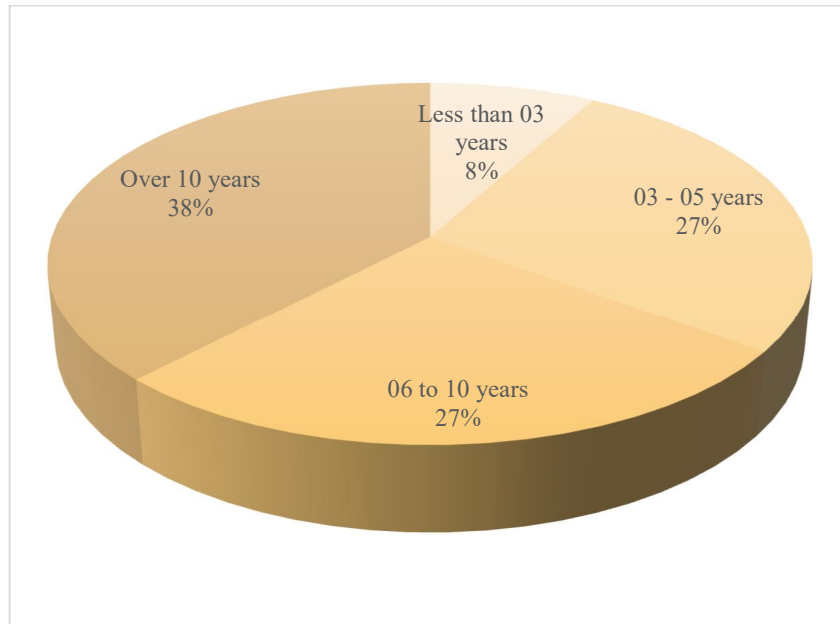


Figure 4. 3:Industry experience of respondents

4.3 Data Analysis and Findings

The data was evaluated using the Relative Importance Index technique, which displays the significance levels for each variable provided by respondents. Respondents were asked to rate their ideas on a Likert scale of 1 to 5, with 1 being significant disagreement and 5 representing strong agreement. For evaluations, the RII Values for each statement were computed and tallied.

The primary elements were identified and analyzed in terms of their influence on various aspects. Bar charts and pie charts were used to illustrate different analytical results. Tables were also included to make it simpler to comprehend the findings.

4.3.1 Use of ERP Systems by Respondents

Figure 4.4 depicts the current state of the ERP system's utilization. Thirty respondents (81% of total respondents) confirmed that their organization uses an ERP system, whereas 07 respondents (19% of total respondents) said that their organization does not utilize an ERP system now.

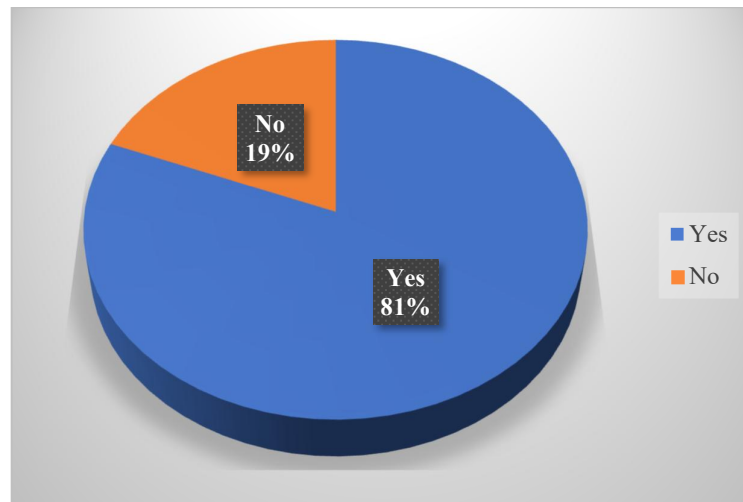


Figure 4. 4: Usage of ERP Systems by Respondents

Moreover, some respondents who do not use an ERP system are from reputed construction firms with the highest CIDA rating, while the rest are from medium scale construction organizations in Sri Lanka.

Further, respondents provided the following reasons for not implementing an ERP system in their current workplace.

- “As per the conclusions made by past researchers, and others' experience, it is not effective. It assists on cost controlling by minimizing wastages but interrupts the progress.”
- Most of the construction Small and medium sized enterprises (SMEs) in Sri Lanka do not practice ERP systems due to lack of knowledge about ERP systems.
- “Cost and time took for admit changes”.

4.3.2 The ERP Systems that respondents were familiar with

There were six ERP products that respondents were familiar with. The SAP is the most popular, and Cirrus PMS coming in second. According to their websites, SAP is a globally renowned ERP application, and Sri Lankan specialists designed Cirrus PMS. Furthermore, respondents have been using SAP for over ten years and Cirrus PMS for over five years. The popularity of each ERP system among respondents is visualized in figure 4.5.

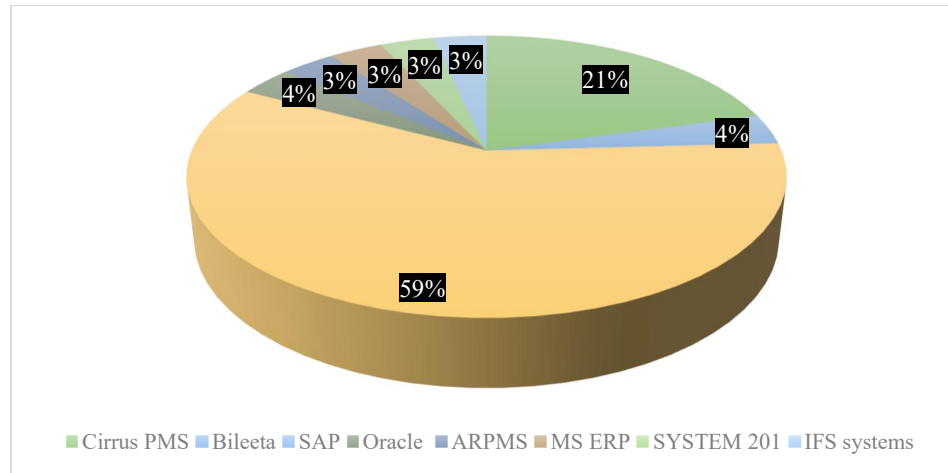


Figure 4. 5: The ERP Systems that respondents were familiar

4.3.3 Experience with ERP systems

Experience with ERP systems in the sample respondents is split into four major groups. Figure 4.6 demonstrates the Organization's experience in the use of ERP Systems.

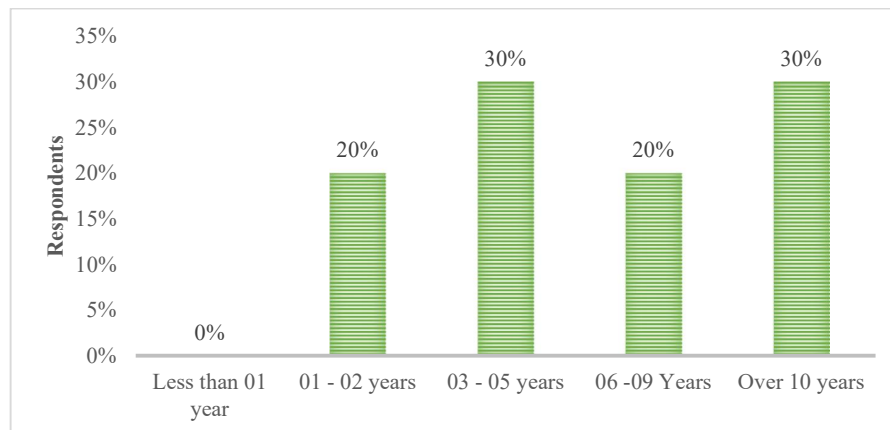


Figure 4. 6 : Organization's experience in the use of ERP Systems

There are equal contributions from those over ten years and 3 to 5 years group, representing 30% among all respondents. Furthermore, all responders with ERP systems had them in place for at least a year. However, 50 % of the population has been competent with ERP systems for more than five years, and 30% have experience for more than ten years. According to the findings, the Sri Lankan construction industry has more than 10 years of experience with ERP systems.

4.3.4 Overview on User awareness of the Benefits of ERP systems

The user awareness about the benefits of ERP systems used in Sri Lankan construction contractor organizations was analyzed to accomplish the first research objective, and it was revealed that more than 80% of respondents were aware of the benefits of ERP systems. The highest ranking was given to the ERP system will increase organizational efficiency above conventional techniques. Furthermore, it ranked second in terms of time savings over traditional/manual approaches. As a result, users who are more familiar with ERP systems are knowledgeable on the benefits of the ERP systems. Table 4.2 shows RII scores concerning user awareness of the benefits of ERP systems.

Table 4. 2: User awareness of the benefits of ERP systems

Sr. No	Statement	Total respondents (N)	RII	Rank
1	It saves time than traditional/ Manual methods	37	89%	2
2	Increase the efficiency in the company than Traditional/ Manual Methods	37	91%	1
3	Helps to take timely decisions based on real-time data	37	84%	3
4	Helps to manage resources properly	37	83%	4
5	Facilitates managing construction project efficiently	37	82%	5
6	Creates communication platform across the Organization	37	65%	6

The responses to the assertion that the ERP system creates a communication platform across the organization which has the lowest RII score are depicted in Figure 4.7. Furthermore, it is possible that 32% of respondents were unaware of such benefits while 16% were neither aware nor unaware of such feature.

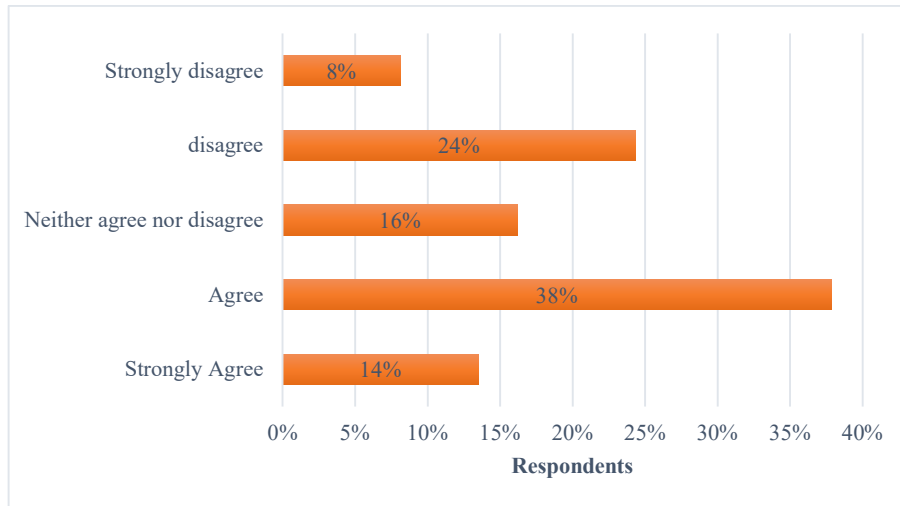


Figure 4. 7: responses on the ERP system create a communication platform across the Organization.

4.3.5 Key activities on selecting the ERP system

The responses of 30 individuals from the organizations which are currently practicing ERP systems were evaluated to identify the existing ERP implementation process used by Sri Lankan construction contractor organizations and yield RII values, shown in table 4.3. Moreover, the second research objective was addressed from the outcome.

Table 4. 3: Key activities on selecting the ERP system

Sr. No	Statement	Total respondents (N)	RII	Rank
1	Selection of ERP system was done after careful review & analyzing the products available in the market	30	79%	2
2	Concerned about the Vendor support as a critical factor in the selection of ERP	30	79%	2
3	Did not Consider the possible future expenses for enhancement of system hardware	30	80%	1
4	Costs associated with user training was not properly planned	30	73%	5
5	Proper evaluation was done for the cost of the product, license fee & maintenance fee	30	78%	3
6	Carefully reviewed how the ERP system affect to existing business process	30	77%	4

The results proving that the majority of fundamental aspects which the previous researchers have identified as critical in obtaining an effective ERP System, were concerned by the construction organizations in Sri Lanka.

The highest RII value was received on the assertion that their organization does not consider potential future costs for system hardware enhancement, which is 80%. Figure 4.8 represents the response to the above statement. The results show that their organizations did not budget for anticipated future costs for system hardware expansion, which might be owing to being ignorant of such an occurrence.

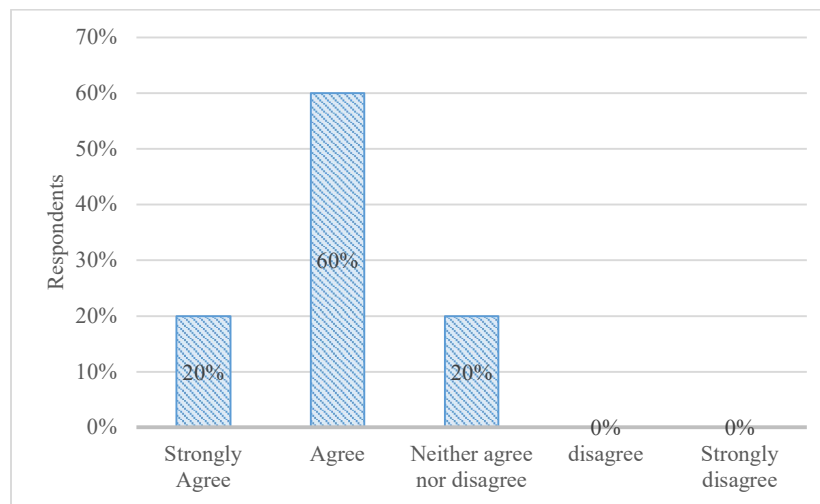


Figure 4. 8: Responses for 'did not consider the possible future expenses for enhancement of system hardware'.

When expanding the ERP system to new project offices, the internet bandwidth may need to be increased to maintain efficiency with adequate processing speed. Furthermore, with new business growth, the capacity of cloud storage may need to be increased. Therefore, if the system hardware utilized for the ERP system was not adequately designed to meet the needs of future business expansions, the firm will incur significant costs unless the ERP system's proper functioning is compromised. Further, this has been concluded by previous researchers. Hence, this should be taken into consideration when selecting an ERP system.

The statement about user training expenses not being appropriately anticipated received the lowest rating of 73%. Moreover, only 10% disagreed with the idea, and 60% were agreed or strongly agreed with the statement. Figure 4.9 depicts the specifics of the statement's responses. Furthermore, it demonstrates that appropriate planning for the expenditures related to user training was not done.

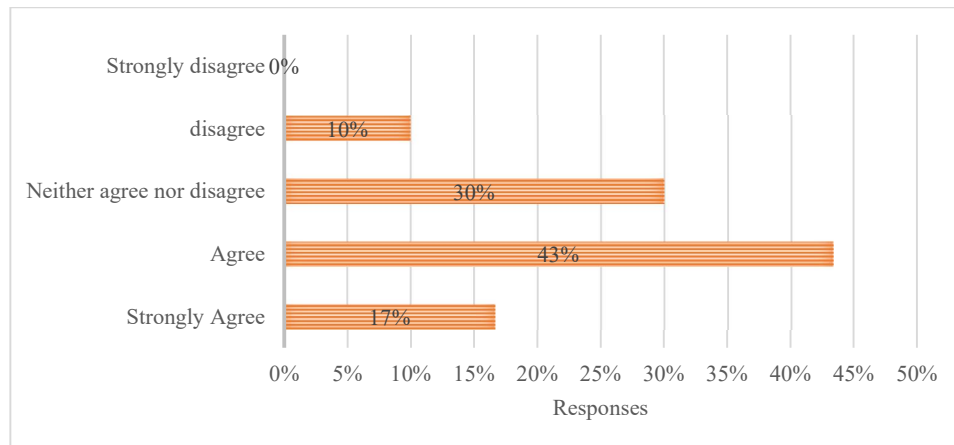


Figure 4. 9: Frequency of responses for the cost of user training was not properly planned

4.3.6 Top Management Support for the ERP System Implementation

One of the essential aspects of ERP success is top management support. This subsection's questions also addressed the one of the research objectives for identifying the existing ERP implementation process. Furthermore, respondents affirmed that top management's support for ERP systems has a positive relationship, and the results were summarized in Table 4.4.

Table 4. 4: Top management support with ERP system

Sr No	Statement	Total respondents (N)	RII	Rank
1	Approves all required resources without any restriction	30	77%	2
2	Supports on arranging user training programs for newly recruited Staff	30	75%	3
3	Performance measurements were carried out few cycles after the "Go Live" phase	30	60%	5
4	Given token of appreciation after obtaining successful user training	30	72%	4
5	Information in the ERP system is considered for business decisions	30	80%	1

More than 87% of respondents indicated that their organization used the information in the ERP system for business decisions,” which was ranked highest in terms of RII value. Alternatively, there are around 3% of responses against the stated assertion, while 97% are slightly or completely agreed.

The responses to the preceding argument are depicted in Figure 4.10. Furthermore, this indicates that management has faith in the information or outcomes of the ERP system, which may be viewed as a positive influence on successful ERP implementation.

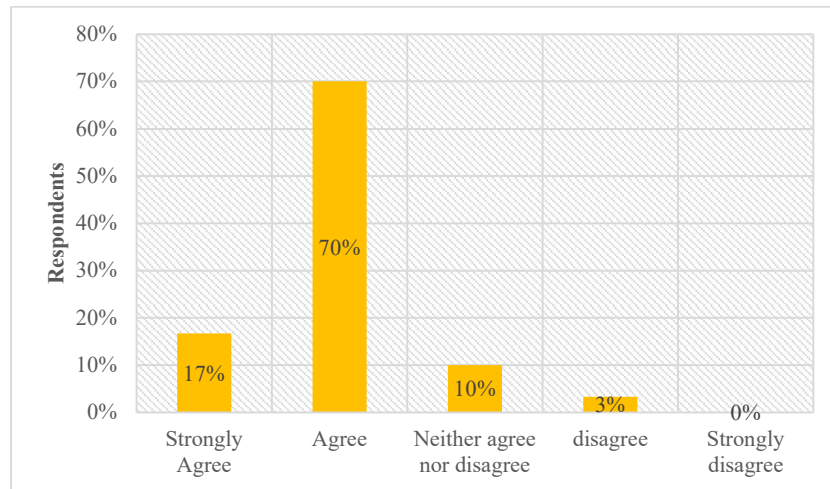


Figure 4. 10: Information in the ERP system is considered for business decisions

However, users were dissatisfied with the reaction from top management; the statement that “Performance measurements were carried out few cycles after the "Go Live" phase” received the lowest rating. This might be interpreted as a problem area regarding ERP implementation. Figure 4.11 depicts the responses of the above argument.

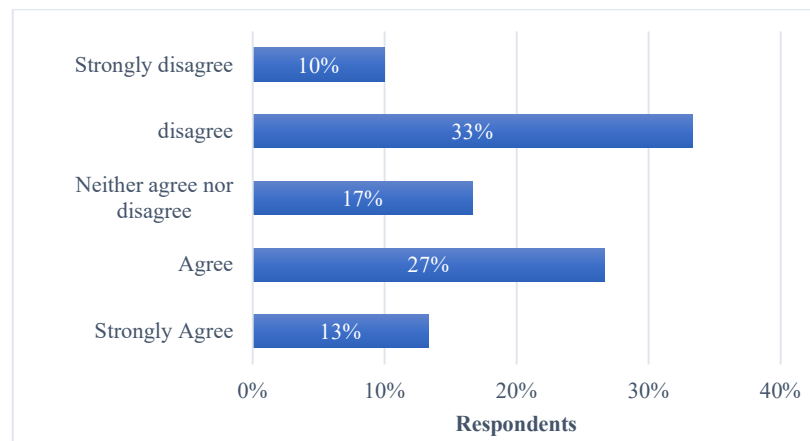


Figure 4. 11: Performance measurements were carried out few cycles after the "Go Live" phase.

Previous studies also showed that performance measurements should be accomplished a few cycles after the Go-live phase. Furthermore, expecting results before completing the implementation stage would not provide management with an accurate image of the ERP system's investment. Therefore, vendors that are specialists in ERP systems should consider this aspect and advise the client on this point and advise to carry out performance assessments after a few cycles following the Go-Live phase.

4.3.7 Vendor Support Level on the ERP System

Vendor support is also one of the most vital factors in the success of an ERP system. Questions on ERP vendor support were outlined to determine the existing ERP implementation process and examine current ERP use practices in construction contractor companies in Sri Lanka. The most significant aspect of vendor support is the core user training once the product has been fully developed. The lowest rank given to the vendor support Level is Fully knowledgeable of the business practices in the Sri

Lankan construction industry. Table 4.5 summarizes the responses obtained for the statements on vendor support.

Table 4. 5: ERP Vendor support

Sr No	Statement	Total respondents (N)	RII	Rank
1	Does not respond to queries related to mapping the existing operation with the ERP solution during the implementation stage	30	77%	2
2	Core user training was done after full completion of product development	30	78%	1
3	Support on issues related to the ERP system is not at a satisfactory level	30	69%	3
4	Fully aware of the business practices in the construction industry in Sri Lanka	30	66%	5
5	Could not answer product-related functional questions thrown by the Organization to accommodate requirements	30	69%	4

Referring to table 4.5, the highest RII value scored for the “Core user training was done after full completion of product development”. Consequently, this may be viewed as a positive factor in the success of the ERP implementation. Figure 4.12 demonstrates the frequency of responses to the preceding assertion.

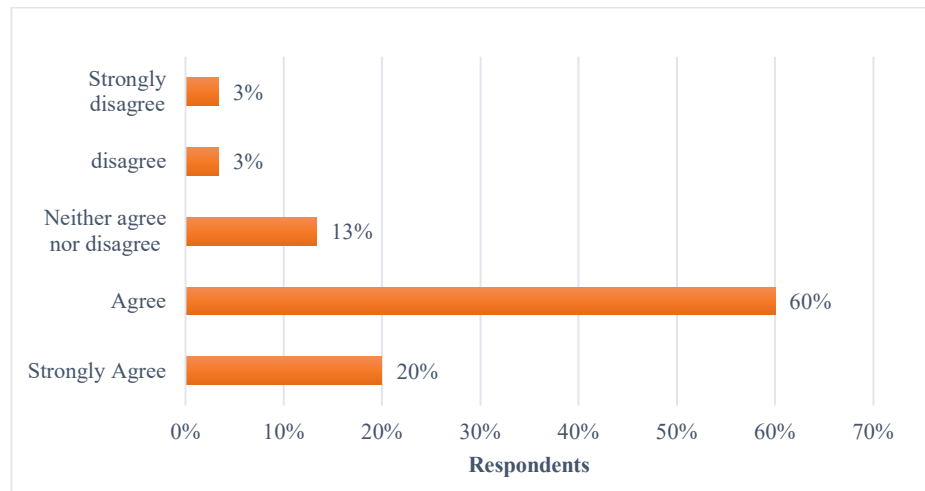


Figure 4. 12: Core user training was done after full completion of product development

Users will not be updated when developments or modifications occur after the core user training, and there may be conflicts because of a lack of awareness about such changes or developments in the system, which leads to incorrect data entry and user dissatisfaction. Furthermore, user training must cover all of the modules or features in the ERP system once the product has been developed.

Based on the findings, except for 7% of respondents, the majority agreed with the allegation that the Vendor did not respond to queries on mapping existing operations with the ERP solution during the implementation stage. The responses to the statement are depicted in Figure 4.13.

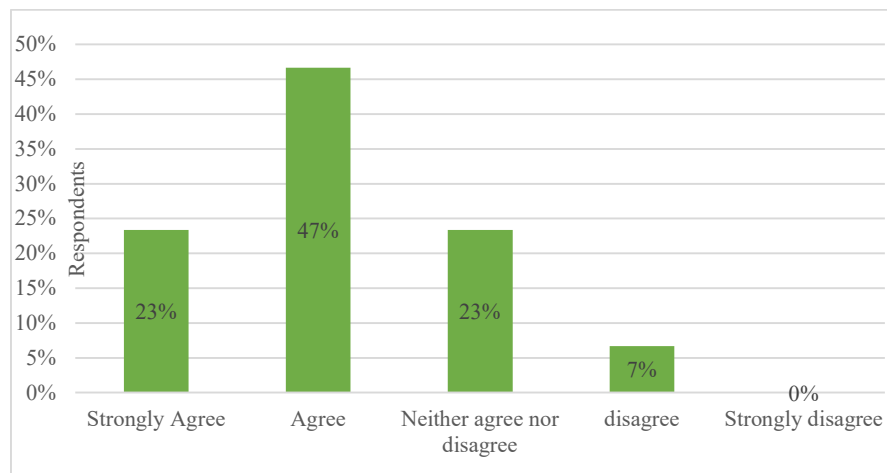


Figure 4. 13: Vendor does not respond to queries related to mapping the existing operation with the ERP solution during the implementation stage

Thus, we may infer that the vendor did not reply to queries about mapping current activities with the ERP solution during the implementation stage, which is one of the primary drawbacks associated with ERP adoption.

The procedures and practices of construction companies are distinctive. Additionally, the existing procedures in construction organizations and the ERP system flow diverge from one another. Hence, mapping of existing processes to the ERP system to be installed is a critical operation. Furthermore, it may have an influence on the ERP system's successful implementation. Consequently, ERP vendors must be well-versed

in both existing construction practices in Sri Lanka and the operation of the ERP software. Similarly, it can be concluded that the ERP Vendors may lack sufficient knowledge of the function of the ERP system that they are about to offer. Figure 4.14 depicts the results. Alternatively, to answer concerns about product-related features, the ERP supplier should have a thorough grasp of the ERP systems.

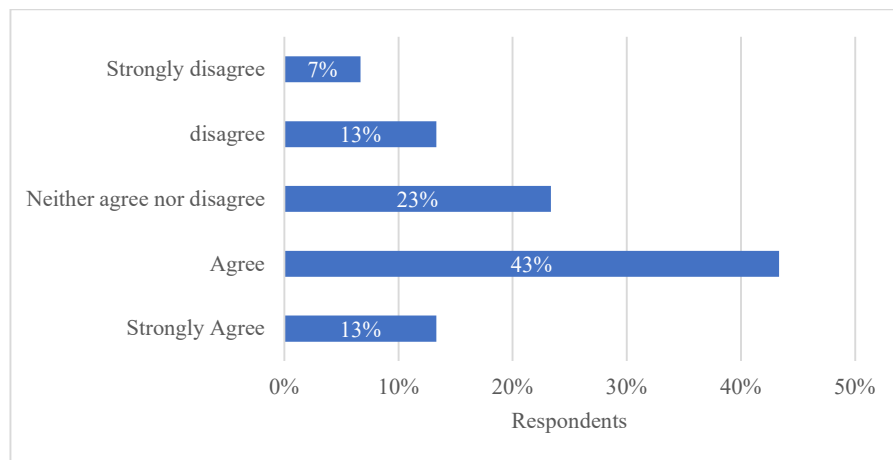


Figure 4. 14: Vendor could not answer product-related functional questions thrown by the organization to accommodate requirements

4.3.8 Satisfaction on ERP User training

The importance of proper user training in achieving the benefits of ERP implementation cannot be overstated. Previous studies showed that users' unfavorable views may be altered by providing adequate training.

Responses to satisfaction with user training were examined to assess the existing ERP implementation process and examine current practices on ERP use in Sri Lankan construction contractor organizations. The highest rank was obtained for adequate training on ERP Implementation. The lowest RII value of 67% was received for User training received from one of the team members. Table 4.6 summarizes the responses on ERP user training satisfaction.

Table 4. 6: Satisfaction with user training

Sr No	Statement	Total respondents (N)	RII	Rank
1	User training did not cover all the modules and the functions in the ERP system	30	77%	2
2	sufficient training was received on ERP Implementation	30	78%	1
3	All the required training materials & resources were timely arranged during training sessions	30	77%	2
4	On-the-job training from time to time for user awareness about product/module upgrades is not being carried out	30	71%	3
5	Gained the training from one of the team members	30	67%	4

According to the findings, the statement on adequate training received at the ERP implementation stage scored the highest RII value. Figure 4.15 illustrates the outcome of the preceding argument which was agreed upon by more than 80% of the respondents. This will have a beneficial influence on the successful deployment of ERP.

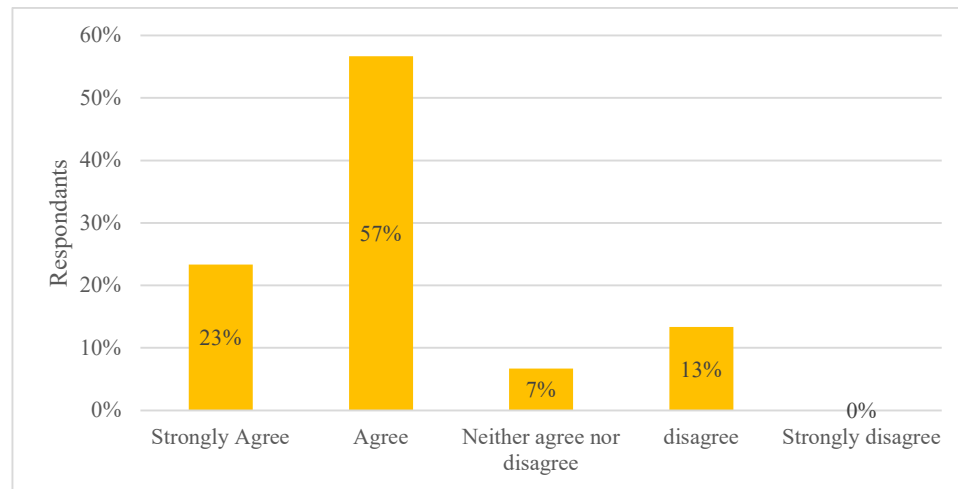


Figure 4. 15: Sufficient training was received on ERP Implementation

Conversely, the second highest RII value scored for the training offered did not cover all the ERP system's features or modules. Figure 4.16 reveals that more than 74% of respondents agreed with the opinion. It can also conclude that the training on ERP

systems only addresses the areas that are unique to each user which can be identified as a constraint in current ERP practice.

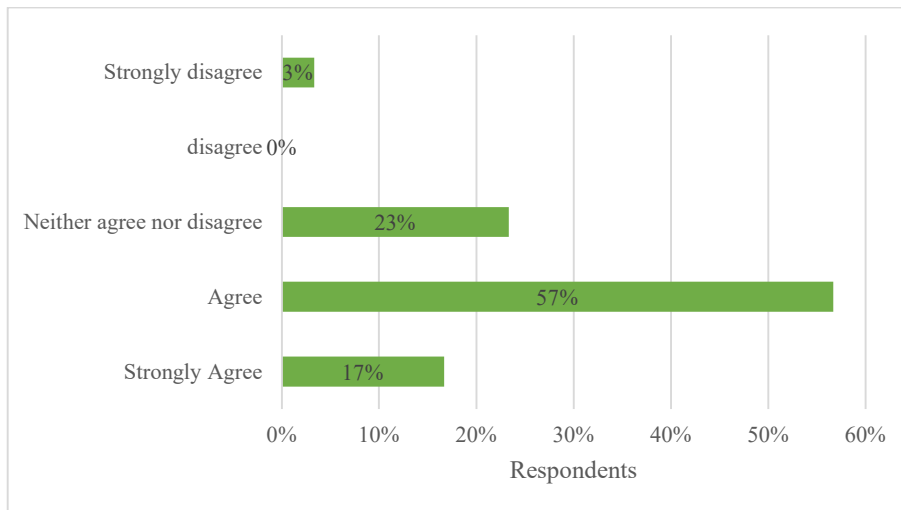


Figure 4. 16: User training at ERP Implementation does not cover all the modules and the functions in the ERP system

Therefore, user training should cover all functionalities in ERP systems so that users have a thorough understanding of the ERP system's workflow. Thus, user training directly impacts user satisfaction with the ERP system, and training that covers all functions in the ERP system will improve user satisfaction while also boosting efficiency.

4.3.9 Current practices with the ERP system

Responses to the exploration of existing practices while utilizing ERP systems at construction organizations in Sri Lanka are analyzed and summarized to achieve the third research objective. Following best practices for ERP system use will contribute to ERP success in the organization.

According to the responses associated with current ERP system practices, both positive and negative aspects exist, as indicated in Table 4.7. The highest rank was assigned to manual data collections using alternative methods while the lowest ranked for “each user has a distinct user login ID”.

Table 4. 7: Current Practices with ERP use

Sr. No	Statement	Total respondents (N)	RII	Rank
1	Some data to be collected manually by alternative methods	30	81%	1
2	Data capturing to the ERP system will be on a timely basis/ at the time of transaction	30	75%	3
3	Each user having a dedicated user login ID	30	68%	5
4	Use traditional documentation for approvals	30	70%	4
5	ERP system has been implemented after carefully reviewing the system development of the ERP system match to the existing business process	30	79%	2

Considering the current practices with the ERP use, the highest RII value was received for manual data collection by alternative methods which graphically displays in Figure 4.17. More than 83% of respondents were agreed that they have to collect some input data through manual documents. A few examples are site store requisitions, daily material use, and progress, subcontractor work done records. Manual data collection might result in data manipulations and compromise data accuracy.

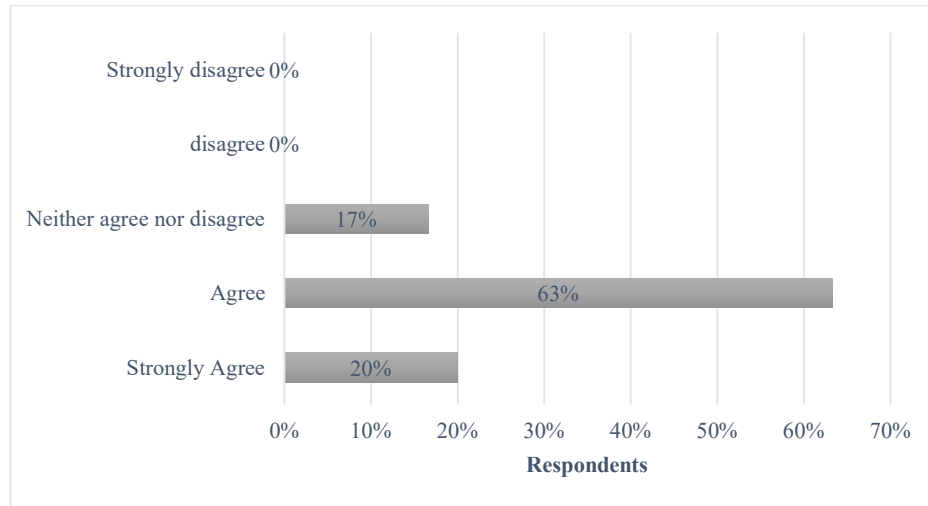


Figure 4. 17: Needs to collect some information manually by alternative methods

Manual data collection is time-consuming, and the accuracy is dependent on the user. Also, it takes extra effort on such data collections. Furthermore, errors in manual data collections will jeopardize the investment in the ERP system.

Hence, ERP vendors should thoroughly evaluate the current processes in the construction Organization and facilitate all possible data capturing facilities through the system using sub-modules limiting to go for an alternative option by users. Additionally, the representatives of the organization must ensure that the ERP system meets the needs of the business before the ERP implementation.

However, many respondents agreed that data capturing to the ERP system will occur in their organizations on a timely basis/at the time of the business transaction. Figure 4.18 represents the findings of just 3% of respondents who disagree with the argument. Thus, to get the real benefit of the ERP system by obtaining real-time information, all records must be captured without keeping any backlog. Further, this will have a beneficial impact on the success of ERP system adoption.

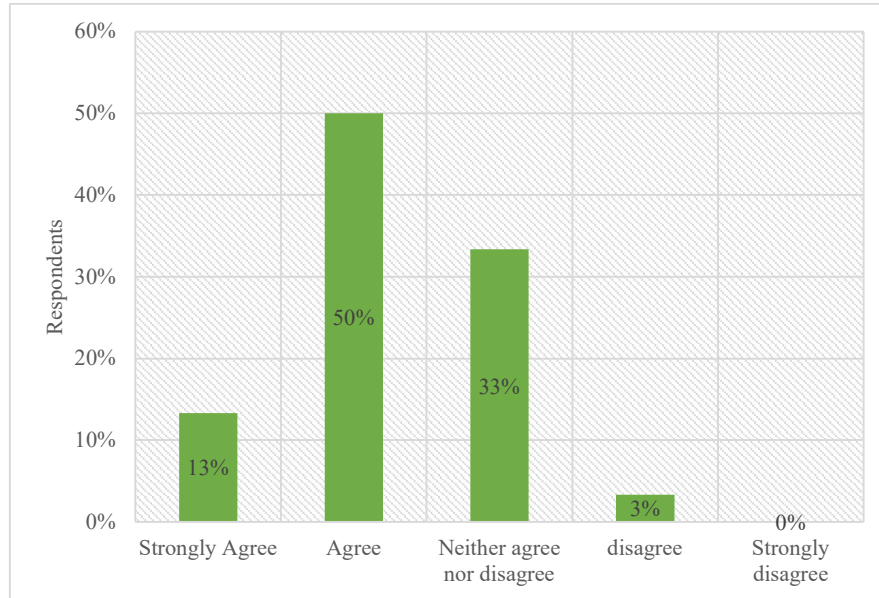


Figure 4. 18: Data capturing to the ERP system will be on a timely basis/ at the time of transaction

4.3.10 Review the overall satisfaction of ERP users

User satisfaction is an important determinant of ERP system success. An analysis was performed to illustrate a part of the research objective of examining existing practices when utilizing ERP systems in Sri Lankan construction organizations. Table 4.8 outlines responses to the ERP users' overall satisfaction.

Table 4. 8: ERP user satisfaction

Sr. No	Statement	Total respondents (N)	RII	Rank
1	The architecture of the ERP system is attractive and easy to access	30	83%	1
2	Some reports are not available in the system	30	73%	5
3	Does not have the facility to access by mobile phone to feed/ retrieve data	30	76%	3
4	Can quickly upload/retrieve data to the system without any buffer time	30	77%	2
5	The duties assigned in the ERP system are matching with your job scope	30	75%	4

According to the RII values measured, “The architecture of the ERP system is appealing and easy to access”, obtained the highest value. 97% of respondents agreed with the statement. The results are visually depicted in Figure 4.19.

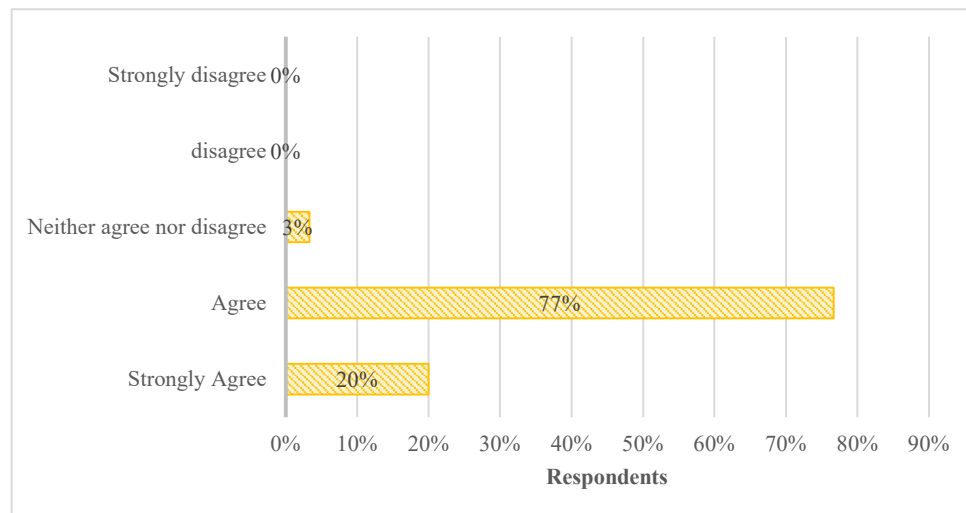


Figure 4. 19: The architecture of the ERP system is attractive and easy to access

As per the findings, users are pleased with the ERP architecture. Eventually, this will have a favorable effect on the success of ERP. Accordingly, it can be concluded that the ERP system is simple to use. Furthermore, users are comfortable with the tasks delegated in the ERP system.

However, the statement "Some reports are not available in the system" had the lowest RII value, with just 3% disagreeing, as shown in Figure 4.20. Reports are unique to each organization, and users must manually produce them if they are not available in the ERP system, which takes extra time and reduces the accuracy of such reports.

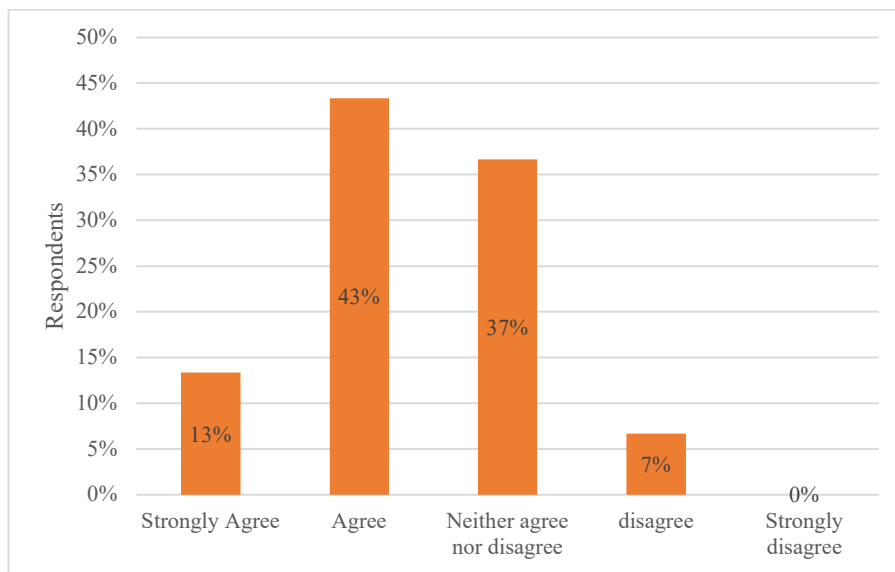


Figure 4. 20: Some reports are not available in the system

Since all critical data is captured in the ERP system, reports could be created from the system to meet the user's needs. Consequently, needed reports should be determined before system development by the customer, and ERP vendors should provide such reports available via the ERP system while eliminating manual reports.

4.3.11 Problematic areas when using the ERP system

Problems encountered when utilizing a system have a direct influence on user dissatisfaction, resulting in a negative impact on ERP success. Table 4.9 shows the results of the analysis of responses to determine the problem areas or significant constraints associated with ERP use.

Table 4. 9: Problematic areas when using the ERP system

Sr. No	Statement	Total respondents (N)	RII	Rank
1	Your work performance restrained by the ERP system due to manual data collections/ approvals	30	79%	1
2	Does not have access to some of the Modules/ Reports which are helpful in your job role	30	75%	2
3	Need to work additional hours to feed data	30	56%	4
4	Most of the time, need to wait to log in to the system because of the use of a shared login ID	30	57%	3
5	Limitations on access to ERP system remotely (at the construction site or outside the office)	30	75%	2

The statement that “work performance restrained by the ERP system due to manual data collections/ approvals” has the highest RII value and could be highlighted as a key problem area in current ERP operation. As an outcome, managers must be trained on using the built-in function in the approval process rather than relying on traditional ways. Besides, respondents acknowledged that they had access restrictions while using the ERP system from remote locations. This might also lead to manual data collection, which can be considered a constraint.

There are both positive and negative responses to the question "Need to work more hours to feed data." responses are visualized in figure 4.21.

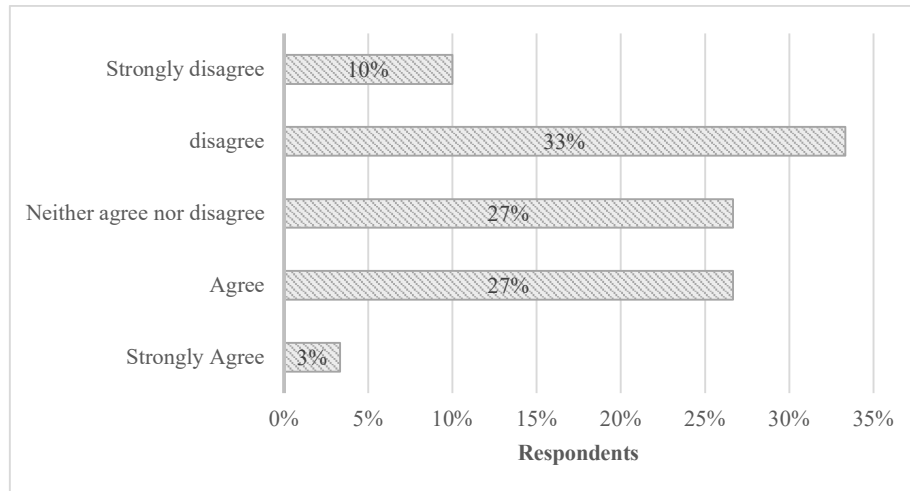


Figure 4. 21: Need to work additional hours to feed data

Only 30% of respondents who agreed with the statement might have to do manual data gathering or approvals. Furthermore, new users who have not received adequate training or knowledge of the ERP process may believe that they must work longer hours due to the activities on the ERP system.

Similarly, it is possible to conclude that access restrictions to some modules/reports supporting the work function are a burden from the users' point of view. The responses to the statement are depicted in Figure 4.22. There are 10% of few respondents disagreed with the argument.

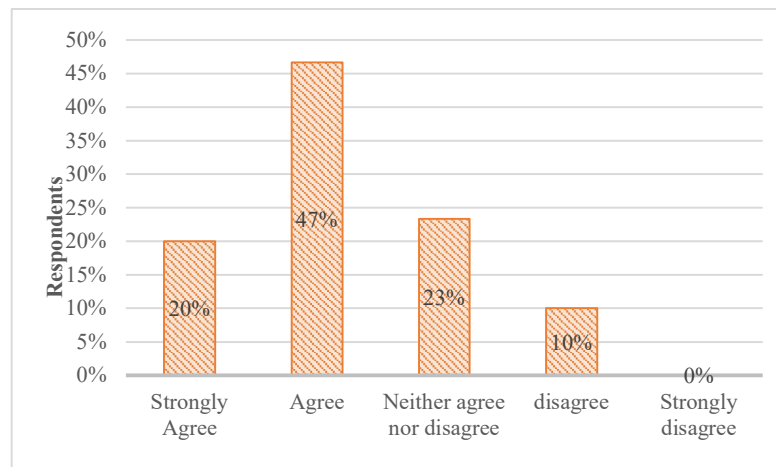


Figure 4. 22: Does not have access to some of the modules/ reports which are helpful in your job role

To protect data privacy and security, user limitations on access to such modules or reports will be enforced. However, the responsible parties, such as a system administrator, must do a thorough investigation before creating user profiles in the ERP system and granting any rights that may be beneficial to individual users following the policy of the particular business. Unless users might not get the real benefit of ERP use.

Therefore, assessing the necessity for such access on modules/reports to be completed on time and granting permissions can enhance user satisfaction and efficiency.

4.3.12 Responses on Recommendation of ERP systems for construction contractor organizations.

According to the findings, 89% of respondents recommend ERP systems for construction contractor organizations in Sri Lanka, while just 11% disagree. Figure 4.23 depicts the findings.

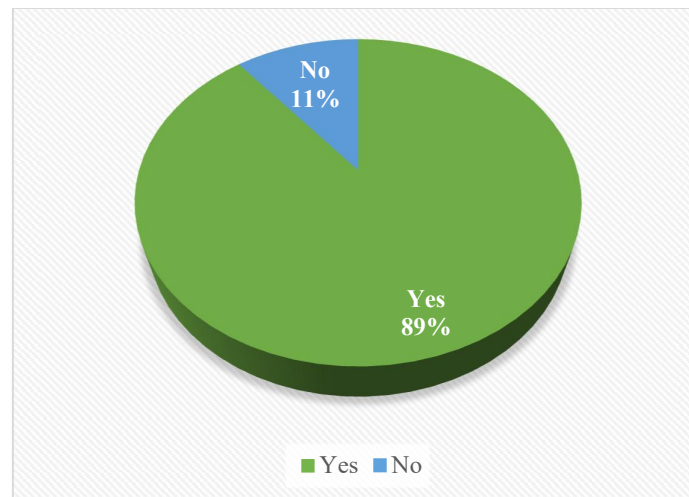


Figure 4. 23: User recommendation of the ERP systems for construction contractor organizations in Sri Lanka

4.3.13 Strategies for successful ERP implementation at the Construction Contractor Organizations in Sri Lanka.

The entire responses were carefully evaluated to determine good practices in ERP implementation to meet the last objective of suggesting good practices for implementing ERP in Sri Lankan construction companies. As stated by table no. 4.3 on responses for key activities on selecting an ERP system, the selection of an ERP system should be done after thoroughly reviewing and analyzing the products available on the market that have scored 79 percent of the RII value. Furthermore, a careful examination of how the ERP system influences the current business processes has resulted in a 77 percent RII value. According to the literature review, previous researchers determined that ERP system training had a great influence on successful implementation. Furthermore, user training will boost user knowledge of the ERP System's benefits. The majority of respondents acknowledged that they had adequate user training, which will assist in the effective ERP implementation.

At the same time, they argued that the user training did not cover all the ERP system's modules and features. Figure 4.24 depicts the outcome based on Table 4.6, which summarized the responses on ERP user training. Only 3% of the respondents disagreed with the assertion.

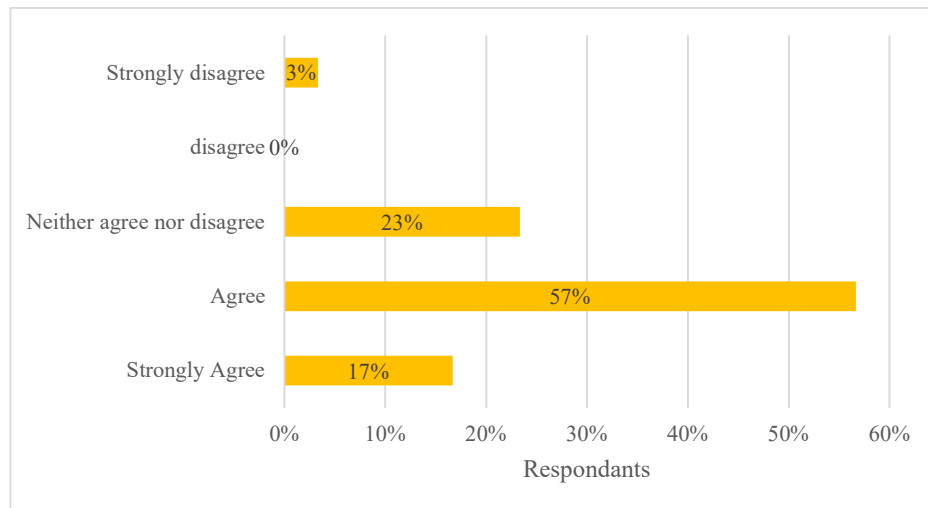


Figure 4. 24: User training at ERP Implementation does not covered all the modules and the functions in the ERP system

Based on the responses on ERP vendor support summarized in table 4.5, the statement on the Vendor is Fully aware of the business practices in the Sri Lanka construction industry received the lowest RII score. Figure 4.25 depicts the frequency of responses to the statement.

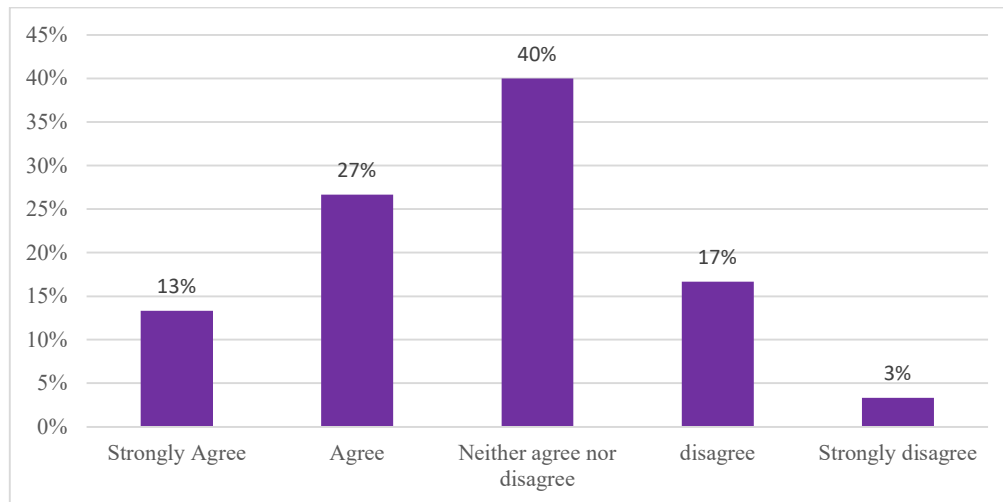


Figure 4. 25: ERP Vendor is Fully aware of the business practices in the construction industry in Sri Lanka

Only 40% of respondents agreed with the statement, implying that some ERP vendors are unaware of the procedures in the Sri Lankan construction sector, which differ slightly from those in Western or Middle Eastern nations in the world. According to previous studies, many ERP solutions developed in Western nations may not be suitable for the Sri Lankan construction industry's culture. Thus, before introducing an ERP system, ERP vendors must have a complete grasp of the functions and nature of Sri Lankan construction organizations.

When assessing the problematic areas when using the ERP system in table 4.9, many respondents agreed with the opinion that the ERP system impacted their work performance due to manual data collection/approvals. Figure 4.26 depicts responses to the preceding statement to aid comprehension.

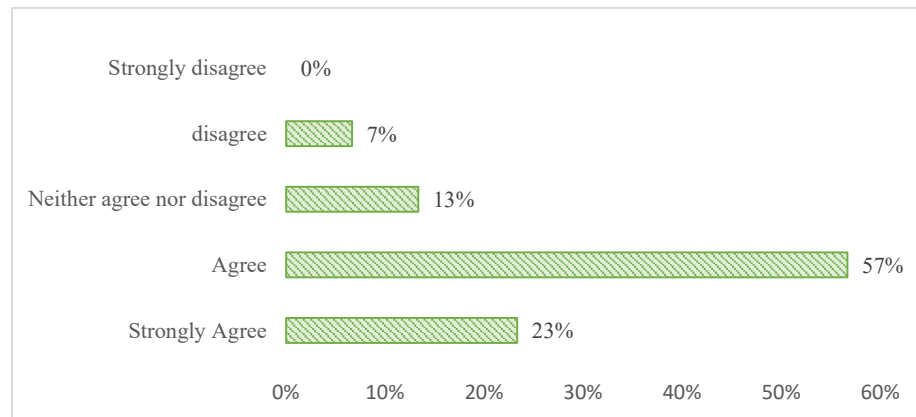


Figure 4. 26: Your work performance restrained by the ERP system due to manual data collections/ approvals

Only 7% of respondents disagreed with the statement, while more than 80% agreed with it. As a result, it is fair to argue that users must engage in manual paper tasks to gather data or approve processes that need extra time and effort will negatively affect to user satisfaction. Furthermore, this will have an impact on the effective implementation of an ERP system. Manually preparing reports, as detailed in the preceding subsection, is also a hassle for ERP users. Thus, the absence of some management information repositories is a significant constraint for ERP success. Furthermore, as identified in the previous subsection, access restrictions will be a constraint for ERP success. As a consequence, granting access permissions complying with company data policies will aid users in reaping the benefits of the ERP use.

4.4 Summary

The findings of the structured questionnaire were presented in this chapter. The first portion examined the results of demographic questions, while the second examined the Likert scale questions and other information obtained from the questionnaire. Respondents have been using SAP for more than ten years and Cirrus PMS for more than five years. The data show that the Sri Lankan construction sector has more than ten years of ERP systems experience. And 87% of respondents are recommending ERP systems for Sri Lankan construction contractor organizations. Further respondents have made suggestions on successful implementation of ERP system based on their own experience.

The composition of respondents from Sri Lankan construction organizations includes quantity surveyors, engineers, project managers, account/ finance, and human resources/admin officials. Furthermore, 30 respondents (81%) now use an ERP system in their organization, while just 07 respondents (19%) said that their organization does not currently use an ERP system. The majority of respondents had over ten years of industry experience, with only 8% having fewer than three years' experience.

The questionnaire assisted in determining the user knowledge on the benefits of ERP systems used in Sri Lanka. It also aided in identifying the existing ERP implementation strategy used by the Sri Lankan construction contractor organizations. The questionnaire revealed current practices in Sri Lankan construction firms on the use of ERP systems and problematic areas or significant constraints related to ERP use.

Conversely, it was observed that some of the most reputable construction contractor firms with the highest CIDA rating do not utilize an ERP system due to the expense and time required to admit modifications. Moreover, they consider that the ERP assists in cost controlling by minimizing wastages but interrupts the progress. Further, they believe that the ERP systems are not effective as per the conclusions made by past researchers.

Nevertheless, addressing those significant issues clearly would increase the effectiveness of the ERP system and the attractiveness of constructing organizations in Sri Lanka. In the next chapter, the conclusions based on the findings to achieve the research objectives are provided. When contemplating ERP implementation tactics, a comprehensive assessment of existing practices in the organization will aid in identifying the gap between the ERP system and facilitating optimal system development to fit the business. Furthermore, user training should cover all modules/features in the ERP system to provide users with a better grasp of how the ERP system would aid in day-to-day activities and its advantages.

The ERP vendor must be knowledgeable about the Sri Lankan construction industry to provide an optimal ERP system for the business. To reduce manual work, ERP vendors should also make data collecting easier through the system and give the ability to generate all essential reports from the system. They should also educate consumers on how to perform management approval for business processes using the system to save time.

5. CONCLUSIONS AND RECOMMENDATIONS

This chapter presents findings and results derived from the data analysis and literature review to conclude recommendations. Findings are used to demonstrate the effectiveness of ERP systems used in contractor organizations in Sri Lanka and to propose good practices to implement ERP in construction companies in Sri Lanka.

5.1 Conclusions

ERP systems are becoming popular in Sri Lankan construction organizations, which are attempting to spend substantially on ERP solutions to chase the advantages given while achieving corporate excellence. This study aims to make recommendations to improve the effectiveness of the ERP systems utilized in Sri Lankan construction contractor organizations.

The response rate was 39%, with the consequences of the COVID 19 global pandemic crisis being the primary cause for the low response rate. The findings show that the Sri Lankan construction industry has more than ten years of experience adopting ERP systems. Furthermore, construction organizations in Sri Lanka have the option to both locally and foreign-developed ERP systems.

Below section explains how the research objectives have been achieved.

Objective 1: Review the ERP systems used in construction contractor organizations globally.

A comprehensive literature review was done to reveal and gather information about the subject matter of the research topic. And, review of the ERP systems used in construction contractor organizations globally was the first objective of the study. Even though the ERP systems were originally designed for manufacturing environments but has now been recognized in the field of project management, and vendors offer packages that allow project managers to cope with priorities,

timeframes, allocating scarce resources, operating costs, and forecasts in an integrated manner, all while being linked to accurate and up-to-date corporate data. Further, An ERP system is an important decision support solution that enables construction companies to effectively manage construction projects quite smoothly throughout the project life cycle.

A typical ERP system includes an accounting and financial module, a human resources management module, a manufacturing module, a procurement management module, a distribution and supply chain module, and a project planning and scheduling module offering management with information for decision making. The ERP market is dominated by a few major players, including SAP, Oracle, and Microsoft Dynamics, and it is rapidly rising.

According to the previous literature, an ERP gives the project management team resources and functionalities to streamline project data and reports during the project life cycle and one of the most effective and vital factors is the potential for the supervisors involved to work proactively on projects where resources are behind the plan, increasing the probability that the project can be executed on time and profitably. Hence, an ERP system may be thought of as an intangible asset to a construction firm. Presently, major construction firms are using ERP systems as a computerized IT solution to successfully manage the working in diverse activities and services, notably those linked to project financial reporting procedures and processes.

Objective 2: Determine user awareness on the benefits of ERP systems used in Sri Lankan construction contractor organizations

The questionnaire survey assisted to attain this objective. According to research, the majority of experts in Sri Lankan construction organizations are aware of the primary benefits of ERP systems. Moreover, users who are experienced with ERP systems are more aware of the ERP systems' benefits. Furthermore, they perceive that the ERP system improves organizational efficiency while saving time over traditional methods.

In contrast, it was observed that ERP users were somewhat unaware of the primary function of the ERP system, which functions as a communication platform throughout the organization.

Objective 3: Identify the current ERP implementation process being utilized by Sri Lankan construction contractor organizations.

The questionnaire survey was used to achieve this objective, and it was discovered that the majority of fundamental aspects previously identified by the researchers as critical in obtaining an effective ERP system, such as carefully reviewing and analysing available ERP products, concern on vendor support, proper evaluation on cost of product and license and maintenance fee, are concerned on by the Sri Lankan construction organizations. Furthermore, a thorough examination of how the ERP system affects the existing business processes was carried out.

However, it indicates that adequate planning for user training expenses was not conducted appropriately. Also did not budget for anticipated future costs for system hardware expansion, which might be owing to being ignorant of such an occurrence. Furthermore, performance measurements done immediately after ERP implementation result in user dissatisfaction and cannot assess ERP success. According to the findings appropriate user training was done during the ERP implementation and that top management's support for the ERP systems has a positive relationship.

Objective 4: Examine the current practices when using ERP systems in construction contractor organizations of Sri Lanka.

The questionnaire survey was used to accomplish this objective. It was discovered that the top management has faith in the information or outcomes of the ERP system and supports the proper function of the ERP system.

Data capturing to the ERP system will occur in their organizations on a timely basis/at the time of the business transaction. However, users must acquire certain data manually or through alternate means, which requires more effort and time. Furthermore, the accuracy of the data is reliant on the user.

The use of a shared login ID to access the ERP system generates disagreements over the responsibility of input data and leads employees to work longer hours to complete their tasks. However, the ERP system is effortless to use, and the users are comfortable with the assigned responsibilities in the ERP system. Eventually, this will have a favourable effect on the success of ERP.

Objective 5: Determine the challenges or significant constraints associated with ERP use.

The latter part of the literature review and the questionnaire survey aided to achieve the objective of determine the challenges or significant constraints associated with ERP use. The ERP vendors may be unfamiliar with the activities in the construction industry and the functions of the ERP system that they are about to offer. Meanwhile, the availability of consulting services to guide the selection of ERP systems is extremely limited and exorbitantly expensive in Sri Lanka.

People working in the construction sector have hostile attitude and resistance to ERP implementations, which increases the failure rate of ERP system implementation. Moreover, training a large number of employees became a challenge, and it was not just a matter of user training, but also of re-training the whole population who were meant to work in a segregated workplace. Further, the ERP user training only targets the elements that are unique to each user, which may be seen as a restriction in current ERP practice. Moreover, the new users who have not received adequate training or knowledge of the ERP process may believe that they must work longer hours to complete their work due to the activities on the ERP system.

Access constraints while accessing the ERP system from remote locations which also lead to manual data collection might be a problematic area. Similarly, access limitations to various modules/reports supporting the work function are also a burden from the users' perspective. Similarly, manual paperwork (printed documents) for approvals, which takes more time, and users have to work longer hours might be an issue in typical ERP operations. Likewise, the lack of certain management information reports is a key constraint in the ERP System.

Objective 6: Propose good practices to implement ERP systems in Sri Lankan construction contractor organizations.

To achieve the last objective of proposing good practices to implement ERP systems in construction contractor organizations in Sri Lanka, responses from the overall questionnaire related to Key activities on ERP selection, current practices on ERP use, vendor support, and problematic areas were considered. ERP implementation that is successful will aid in corporate growth while also easing the day-to-day operations of ERP users. Conversely, the literature review and the survey findings were aided to demonstrate the suggestions.

A ground study has to be done on the company before system implementation and the system must be architect accordingly. Then the users are pleased with the ERP architecture. Moreover, offering adequate user training in all components of the ERP system will aid in increasing both user awareness and the user satisfaction. The fruits of the ERP system could only be harnessed if it has been introduced covering 360 degrees where everything will be generated through the system. Therefore, ERP vendors should extensively examine the present processes in the construction organization and enable all potential data capturing facilities through the system utilizing sub-modules, rather than limiting themselves to find choices. Furthermore, before implementing the ERP system, the organization's representatives must confirm that the ERP system fulfills the needs of the business. Subsequently, on-time data collection to the ERP system will also have a favorable impact on ERP success.

Since all critical data is captured in the ERP system, reports could be created from the system to meet the user's needs. Consequently, needed reports should be determined before system development by the customer, and ERP vendors should provide such reports available via the ERP system while eliminating manual reports. However, controls on accessing sensitive information in the ERP system must be implemented to ensure data privacy and security, which aids in the management of data manipulations.

Meanwhile, assessing the need for such access on modules/reports and granting all possible access permissions that may be beneficial to individual users to be completed on time, as well as granting such permissions following a specific organization's data policy, can improve user satisfaction and efficiency, which contributes to ERP success.

ERP providers should be concerned about the system's flexibility for changes/modifications and troubleshooting to ensure the sustainability of both systems and the end customer.

5.2 Recommendations

This subsection suggests the recommendations which have to be taken into consideration to increase the effectiveness of the ERP systems used in Sri Lankan construction contractor organizations.

- Consultation firms to be developed to assist in the selection of ERP systems.
- Selection of ERP system should be done after careful review & analysing the products available in the market including the cost of the product, license fee & maintenance fee, and the flexibility on changes/modifications and troubleshooting.
- Need to consider all possible future expenses for enhancement of system hardware for the proper function of ERP system.
- Performance measurements should be carried out few cycles after the "Go Live" phase which means after practical completion of a few small-scale construction projects.
- All the transactions related to the construction processes/ activities are to be done through the ERP system without going for manual data collections.
- Facilitate obtaining all required reports from the ERP system without going for manual calculations.

5.3 Further research

The following are the study areas that should be explored in connection to ERP adoption in Sri Lankan construction contractor organizations.

- Investigate the potential of offering an ERP system that is available to all project stakeholders.
- How to effectively use an ERP system for construction project management in Sri Lanka.
- Possibilities on providing single ERP Platform to all the stakeholders in a Project.

5.4 Summary

This chapter covers the conclusion of all findings related to the study's objectives, suggestions made based on the findings in order to fulfill the research aim, including identifying the obstacles on ERP implementation in Sri Lankan construction contractor organizations with logical assumptions, and future research ideas.

The majority of the critical elements that earlier researches determined were vital when acquiring an ERP system. Furthermore, most respondents with ERP system expertise were aware of the important benefits. However, access limits, manual data collection, and the lack of certain management information reports may be significant challenges in the implementation of ERP system in construction contractor organizations in Sri Lanka, as well as the organizations may not reap the full advantages of their ERP system investment. Lack of vendor expertise on Sri Lankan construction practices is also a hindrance to successful ERP deployment. Furthermore, the lack of local Consultation services is a detriment to effective ERP introduction.

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APPENDICES

Sample Questionnaire

Dear Sir/ Madam,

Conducting a Questionnaire Survey for Dissertation

As part of my master's degree program in project management, I am currently conducting research under the dissertation module, which is fundamentally necessary for completing my studies as a post-graduate student at the Department of Building Economics at the University of Moratuwa.

Research topic: Evaluation of the Effectiveness of Enterprise Resource Planning (ERP) Systems used in construction contractor organizations in Sri Lanka

Research Aim: To make recommendations to improve the effectiveness of Enterprise Resource Planning (ERP) systems are used in Sri Lankan construction contractor organizations.

The medium of collecting data will be a questionnaire from the ERP users in the construction contractor organizations in Sri Lanka. I firmly believe that you would support my research by providing your views. The information collected in this questionnaire will be kept strictly confidential and used only for the dissertation. Any of your personnel information will only be used for the dissertation purpose.

Your early response will be highly appreciated.

Yours Faithfully,

R.M.D.S. Rathnayake
179031 G
Department of Building Economics,
University of Moratuwa.

Section I: General Information

i). What is your Name? (Optional)

ii). Name of your Current Organization? (Optional)

iii). What is your Profession?

☐ Project Manager

☐ Engineer

☐ HR/ Admin

☐ Quantity Surveyor

☐ Accountant

☐ Other

iv.) Years of Industry experience?

☐ Less than 03 years

☐ 03 - 05 years

☐ 06 to 10 years

☐ Over 10 years

v). What is the ERP system used in your organization?

..... (Optional)

Vi). How many years has the ERP system implemented in your organization?

☐ Less than 01 years

☐ 01 - 03 years

☐ 03 -05 years

☐ Over 05 Years

Section II: Quiz Questions

To answer the below questions, please use the following Likert scale and tick the relevant box.

1. Overview of **User awareness** on ERP systems. Please rank the below statements according to your knowledge/ understanding of the ERP system.

	Statement	Strongly agree	agree	Neither agree nor disagree	disagree	Strongly disagree
1.1	It saves time than traditional/ Manual methods					
1.2	Increase the efficiency in the company than Traditional/ Manual Methods					
1.3	Helps to take timely decisions based on real-time data					
1.4	Helps to manage resources properly					
1.5	Facilitates managing construction project efficiently					
1.6	Creates communication platform across the Organization					

2. Identify the **Process followed by your Organization on selecting ERP Products**. Please rank the below statements according to your knowledge/ understanding of the ERP system.

	Statement	Strongly agree	agree	Neither agree nor disagree	disagree	Strongly disagree
2.1	Selection of ERP system was done after careful review & analyzing the products available in the market					
2.2	Concerned about the Vendor support as a critical factor in the selection of ERP					
2.3	Did not Consider the possible future expenses for enhancement of system hardware					
2.4	Costs associated with user training was not properly planned					
2.5	Proper evaluation is done for the cost of the product, license fee & maintenance fee					
2.6	Carefully reviewed how the ERP system affect to existing business process					

3. Identify the level of Top Management Support on the ERP system. Please rank the below statements according to your knowledge/ understanding of the ERP system.

	Statement	Strongly agree	agree	Neither agree nor disagree	disagree	Strongly disagree
3.1	Approves all required resources without any restriction					
3.2	Supports on arranging user training programs for newly recruited Staff					
3.3	Performance measurements were carried out few cycles after the "Go Live" phase					
3.4	Given token of appreciation after obtaining successful user training					
3.5	Information in the ERP system are considered for business decisions					

4. Identify the level of Vendor Support on the ERP system. Please rank the below statements according to your knowledge/ understanding of the ERP system.

	Statement	Strongly agree	agree	Neither agree nor disagree	disagree	Strongly disagree
4.1	Does not respond to queries related to mapping the existing operation with the ERP solution during the implementation stage					
4.2	Core user training was done after full completion of product development					
4.3	Support on issues related to the ERP system is not at a satisfactory level					
4.4	Fully aware of the business practices in the construction industry in Sri Lanka					
4.5	Could not answer product-related functional questions thrown by the Organization to accommodate requirements					

5. Identify the level of satisfaction with User training provided. Please rank the below statements according to your knowledge/ understanding of the ERP system.

	Statement	Strongly agree	agree	Neither agree nor disagree	disagree	Strongly disagree
5.1	User training did not cover all the modules and the functions in the ERP system					
5.2	Sufficient training was received on ERP Implementation					
5.3	All the required training materials & resources were timely arranged during training sessions					
5.4	On-the-job training from time to time for user awareness about product/module upgrades is being carried out.					
5.5	Gained the training from one of the team members					

6. Identify the current practices with the ERP system. Please rank the below statements according to your knowledge/ understanding of the ERP system.

	Statement	Strongly agree	agree	Neither agree nor disagree	disagree	Strongly disagree
6.1	Some data to be collected manually by alternative methods					
6.3	Data capturing to the ERP system will be on a timely basis/ at the time of transaction					
6.2	Each user having dedicated user login ID					
6.4	Use traditional documentation for approvals					
6.5	ERP system has implemented after carefully reviewing the system development of the ERP system match to the existing business process					

7. Overall, how satisfied are you with the below statements. Please rank the below statements according to your knowledge/ understanding of the ERP system.

	Statement	Strongly agree	agree	Neither agree nor disagree	disagree	Strongly disagree
7.1	The architecture of the ERP system is attractive and easy to access					
7.2	Some reports are not available in the system					
7.3	Does not have the facility to access by mobile phone to feed/ retrieve data					
7.4	Can quickly upload/retrieve data to the system without any buffer time					
7.5	The duties assigned in the ERP system are matching to your job scope					

8. Identify **the challenges** when using the ERP system. Please rank the below statements according to your knowledge/ understanding of the ERP system.

	Statement	Strongly agree	agree	Neither agree nor disagree	disagree	Strongly disagree
8.1	Your work performance restrain by the ERP system due to paper works for manual data collections/ approvals					
8.2	Does not have access to some of the Modules/ Reports which are helpful in your job role					
8.3	Need to work additional hours to feed data					
8.4	Most of the time, need to wait to log in to the system because of the use of a shared login ID					
8.5	Limitations on access to ERP system remotely (at the construction site or outside the office)					

9. According to your understanding, reason for not practicing ERP systems in some construction organizations?

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.....

10. Do you recommend ERP systems for Project management functions in Sri Lanka?

☐ Yes ☐ No ☐ May be

11. Please make any suggestions on successful ERP implementation at the Construction organization in Sri Lanka.

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