

Assessing Enterprise Resource Plan (ERP) Requirements at a Small and Medium Scale Construction Organization: A Case Study

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Thesis submitted in partial fulfilment of the requirements for the degree of
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ABSTRACT

The manufacturing industry gave birth to enterprise resource planning. It offers a typical in work environment for a company to take part its main corporate administration operations with a unique central database, allowing for the sharing of information and effective communication across management departments.

Enterprise Resource Plan has traditionally been restricted to major businesses in the construction industry. Small to mid-size construction businesses make up a large fraction of construction firms that have either failed to deploy or are unfamiliar with this technology.

The objective of this article is to give a decision-making mechanism for place in order enterprise resource planning module deployment. This study lays out a step-by-step plan for implementing an Enterprise Resource Plan system in the construction sector. This research created a four-step procedure for deploying Enterprise Resource Plan system in the correct order. The first step identifies the most widely utilized Enterprise Resource Plan system modules in the construction sector.

In the second stage, the projected advantages of ERP adoption are specified. In the third stage, the significance index (I) will be defined. The primary findings of the study include a complete list of thirteen ERP modules graded by their use in the Sri Lankan construction sector. Out of thirteen modules, inventory control and logistics, procurement, and project finance and accounting were in top three places.

Key Words: Enterprise resource planning system, Construction Enterprise resource planning system, Small and medium scale enterprise, Cloud Enterprise resource planning system, Vendors of Enterprise resource planning system.

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Table of Contents

DECLARATION OF ORIGINALITY	ii
COPY RIGHT STATEMENT	iii
STATEMENT OF THE SUPERVISOR	iv
ABSTRACT	v
ACKNOWLEDGEMENTS	vi
List of Tables	x
List of Figures	x
List of Acronyms	x
List of Appendices	xi
CHAPTER 1 – INTRODUCTION	1
1.1 Background of the Study	1
1.2 Statement of the Problem.....	3
1.3 Research Objectives.....	4
1.4 Justification of the problem	5
1.5 Scope of the Research.....	6
1.6 Limitations of the Research.	7
CHAPTER 2 – LITERATURE REVIEW	8
2.1 Enterprise Resource Planning (ERP)	8
2.2 The Cloud Enterprise Resource Planning systems	10
2.3 Different vendors of Enterprise Resource Planning systems.....	12
2.3.1 SAP	12
2.3.2 SAP HANA.....	13
2.3.3 SAP Cloud	13

2.3.4 Oracle	13
2.3.5 Oracle Fusion	14
2.3.6 Oracle Cloud	14
2.3.7 Microsoft.....	15
2.3.8 Microsoft Technology.....	15
2.3.9 Microsoft Azure	15
2.3.10 Infor.....	16
2.3.11 Infor ION	16
2.3.12 Amazon Cloud AWS	16
2.3.13 NetSuite.....	16
2.4 The Sri Lankan Construction Industry.....	17
2.5 Construction Materials Management.....	18
2.6 Construction Enterprise Resource Planning Systems	19
2.7 Basic Features of the Construction Enterprise Resource Plan System	20
2.8 Construction Enterprise Resource Planning System Architecture.....	23
2.9 Enterprises of small and medium scale (SMEs).	26
2.9 Importance of Enterprise resource planning systems in small and medium-sized enterprises.	29
2.11 The benefits to small and medium scale construction companies for enterprise resource planning.	31
2.12 Difficulties with implementation of enterprise resource planning by small and medium scale construction organizations.	33
CHAPTER 3 – RESEARCH METHODOLOGY	37
3.1 The Method.	37
3.2 Research Methodology	37
3.3 Questionnaire survey.	38

3.4 Sampling Framework.....	38
3.5 Sampling Technique.	39
3.6 Respondent Profile.....	39
CHAPTER 4 – RESEARCH FINDINGS.....	40
4.1 The Case Study	40
4.2 Methodology	41
4.2.1 Define common Enterprise Resource Plan modules in the construction projects.	43
4.2.2 Weights for Benefit Sub-Criteria	43
4.2.3 Enterprise Resource Plan Modules evaluation.....	44
4.2.4 Enterprise Resource Plan Modules overall ranking.....	44
CHAPTER 5 – CONCLUSION AND RECOMMENDATIONS	49
5.1 Conclusion	49
5.2 Recommendations	50
5.3 Future Research	51
REFERENCES	53
APPENDICES	62

List of Tables

Table 1:- In Sri Lanka, definitions for Small and medium enterprises (Dasanayaka, 2006).....	27
Table 2:- The global index of the modules	45

List of Figures

Figure 1: Operation of Construction Industry (<i>Shi & Halpin, 2003</i>).....	2
Figure 2: Cloud ERP vs. SaaS ERP (Degree et al., 2017).....	11
Figure 3: A three-tier architecture for construction ERP (<i>Shi & Halpin, 2003</i>).....	23
Figure 4: Organization of application in third tier (<i>Shi & Halpin, 2003</i>)	25
Figure 5: Research Methodology (<i>Shi & Halpin, 2003</i>).....	42

List of Acronyms

Acronym	Description
BI	Business Intelligence
CERP	Construction Enterprise Resource Planning
CIDA	Construction Industry Development Authority
EDB	Sri Lanka Export Development Board
ERP	Enterprise Resource Planning
IT	Information Technology
MRP	Material Requirement Planning
RTBI	Real Time Business Intelligence
SME	Small to Medium Scale Enterprises

List of Appendices

Appendix	Description	
Appendix – A	Online survey questioner.....	62
Appendix – B	The profile characteristics of respondents	69
Appendix – C	Criteria Index.....	69
Appendix – D	Index for benefits of Increased Efficiency and cost reduction.....	70
Appendix – E	Index for Improved Decision Making and Improved Information Quality.....	71
Appendix –F	Index for Improved User Satisfaction and Improved Organizational Flexibility.....	72
Appendix – G	Global Index.....	73

CHAPTER 1 – INTRODUCTION

1.1 Background of the Study

A contractor's production capabilities are determined by the availability of resources. A construction company has two kind of resources, in-house resources that it acquires, and external resources that it may buy at the competitive market at a rational value. Due to the various reasons such as time bound need variety of resources, the most difficult one is balancing the supply with demand the overall target is to make the most of the internal resources of the company. Further maintaining the balance between production capabilities and real assignment is hard for the construction company. In detail a construction company can achieve this uniformity by tuning its process in a variety of ways. Such strategic decisions of the company need the utilization of complete information from the organization and the market, otherwise, it is unclear if the firm has made the optimum use of available resources to achieving its own budgeted goals.

People who work in the construction industry always express their dissatisfaction. They make complains about overworking and necessary to work extra when the business is upright, when nosiness is poor, they are concerned about their job security. Some of the construction firms quote at cost due to getting business opportunity. As a result of such decision making, many contractors have gone out of the business. The lowest profit margins have been identified as the primary reason of construction firm letdown (Roozbeh Kangari, 1988).

The process of a construction company is representing in Fig. 1. The internal and external resources available to the company are shown in a diagram.

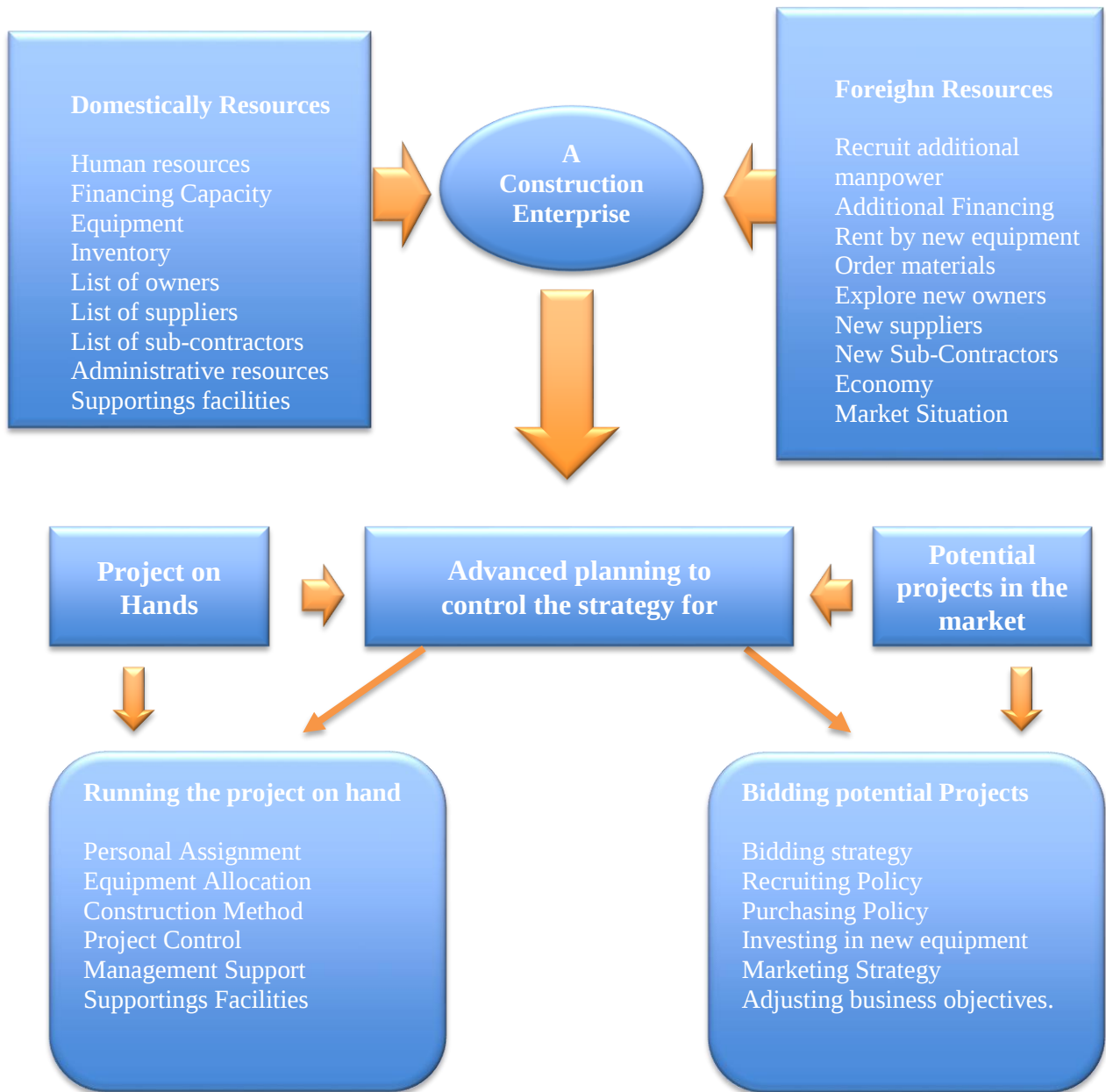


Figure 1: Construction sector operation (Shi & Halpin, 2003)

1.2 Statement of the Problem

Enterprise resource planning (ERP) is a business management and integration approach that allows companies to manage and integrate many elements of their processes. Many Enterprise resource planning software solutions are advantageous to organizations. The Enterprise resource planning (ERP) system can integrate forecasting, acquiring, inventory, sales, marketing, funding, people handling, and other operations.

The construction business is a very much cascading industry. It has to work with other relevant industries, such as suppliers of equipment and materials, vendors, subcontractors and clients, on a widespread basis. Construction businesses use Enterprise Resource Plan (ERP) solutions to increase client responsiveness, reinforce supply chain relationships, boost operational stability, enhance administrative capability and decrease project delivery time and lower costs. These computerized information systems combine and automate some of the company's business operations, including human capital, financial accounting, production, procurement, development, activities, and maintenance. The objective of the Enterprise Resource Plan system is to make data input as simple as possible at the point of generation and to make it available to all members of the company.

With the study it is identified that, most of the construction companies are operated with a conventional method and many of them struggle to apply new Information Technology (IT) things into their operation in order to enhance efficiency and effectiveness of the existing process.

As per Aboabdo et al. (2019) new progression in Information Technology sector provide several tools and techniques to construction industry in order to achieve their goals. Enterprise Resources Planning systems are among such tools that presented possible improvement in managing such organizations. Enterprise Resource Plantings an Information Technology solution that enables industry and their suppliers to manage their projects in efficient way.

From its beginning, the absence of any central information depository has collaborated with different divisions in the organization and the majority of the work undertaken was paper-based. The operation was incredibly long since the employee had to physically

search through the paper papers to find the necessary preserved records. This increases the possibility of human mistake and, as a result, the information's dependability. Furthermore, the Standard Operating Procedures (SOPs) is arbitrary due to a lack of centralized process and information.

The researcher's effort is to discover the most fitting solution for the followings questions through this investigation.

1. What is the most suitable Enterprise Resource Plan Module truly fit with the operational system requirements of the particular Construction Business Organization?
2. How to simplify the existing administrative operation of the organization in order to develop the seamless Enterprise Resource Plan Module?

1.3 Research Objectives

There are many reasons that an organization should implement enterprise solutions. Overall, the top business factors for businesses with Enterprise resource planning systems are improving efficiency, replacing redundant processes, transforming information systems and reducing cost structures (Kamhawi, 2008).

A significant number of global construction firms have increasingly focused on the introduction of incorporated information technology solutions to better integrate different business functions, as enterprise resource planning (ERP) systems. However, these integrated systems face a inclusive range of unique challenges in the construction segment, dissimilar from those in industrial or other service industries.

The main objective of this paper is to identify; what is the suitable ERP module for small and medium construction business organizations in Sri Lanka.

Other sub objectives are as follows,

- Checking the ability of Simplifying as much of the administrative operation of the company as possible.

- Checking the ability of using the Real-time system update and getting access to business information.

1.4 Justification of the problem

Rather of adopting full packages from major Enterprise Resource Plan suppliers, many construction businesses are now deploying Enterprise Resource Plan systems using a unique method where distinct software systems are picked for each operation or occupation. (Tatari et al., 2007).

They combined together a variety of modules from major Enterprise Resource Plan providers, such as financial accounting and human resources, employing tailor interfaces with their own self developed software or other outsource solutions. As a result, in this research, any integrated corporate system that brings together all of the company's essential business operations is deemed the Enterprise Resource Plan system, independent of the accepted implementation strategy. The core cause for this is that construction progressions are less homogeneous than industrial processes, individually project has its own owner, is supervised by a discrete team of project, has its own set of specifications, and so on.

In order to gain benefits from integrating business processes into one IT architecture, companies are willing to invest in Enterprise resource planning programs. Simplifying processes and speeding up the decision-making process are the direct results of this integration. Enterprise resource planning systems are being implemented by more and more organizations from various industries and sectors around the world. This trend shows that such systems are needed to understand the drivers of organizations for the implementation of Enterprise resource planning systems.

Also the researcher identified followings advantages may be obtained by the implementation of the Enterprise Resource Plan systems,

1. Create a collaborative operational situation.
2. Launch automation.
3. Information is available from the bottom level to the controlling level.
4. Every department must connect its applications.

5. Flexibility is the ability to normalize procedures or adjust to different and internationalization.
6. Gaining balanced improvements in individuals, processes and technology in all sectors.

1.5 Scope of the Research

Construction Enterprise Resource Plans are widely discussed by most economists around the world, with the aim of determining to what degree and in what realistic way the same activities can be applied to the construction industry of Sri Lanka. This investigation

- Focuses only on Construction business in Sri Lanka,
- Considers only on Small to Medium Scale Construction companies in Sri Lanka.

This study mainly aims at identifying the most suitable ERP Module that can be used when converting the traditional paper base operational process in to the Enterprise resource Planning with the Small and medium Construction Companies in Sri Lanka.

Currently, the organizations use applications, but they are not linked in a seamless manner. A consultant approaches the marketing manager for ordering something. The marketing manager then checks with the warehouse manager to see if the inventory/stock is still available. If this is not the case, the Warehouse Manager calls the Procurement Manager to request a PO.

The Finance Department is told separately (in many cases, separate approvals from the Financial Department are required). The Inventory is then provided. The warehouse department sends updates to the Purchase and Sales department, and the Sales department contacts the Accounting department, which raises an invoice for the Sales department to submit to the client. This was a regular scenario.

Getting a well-rounded ERP implementation implies a well-connected company. As a result, each department has limited access to other departments. There is no limitation on how much can be accomplished with so few resources. Revenue planning, automated

buying requests, automatic email reviews from leads, automatic accounting due to those accountable operations.

1.6 Limitations of the Research.

Despite the fact that this study produced valid results, it had shortcomings as a result of the limitations encountered. The following are the major limitations:

- One of the major research limitations mentioned in the study is the problem of accessibility.

There are number of construction businesses in Sri Lanka. The researcher does not have access to all of these firms in order to collect data. As a result, only a few firms could utilize it for data collecting.

- Lack of prior studies on the topic.

The researcher was in a difficulty to found out prior studies concerning the implementing the Enterprise resource plan in the Construction industry in Sri Lankan context. This is a good opportunity for the future research over this industry.

- Potential bias of the responders.

This occurs when participants' behavior and attitudes change as a result of participating in the research. This can happen for a variety of reasons, but it's important to understand them all and be managed with each type of response bias.

CHAPTER 2 – LITERATURE REVIEW

The fundamentals of Enterprise Resource Planning systems are explained in this study, as well as what the future holds in this regard. To make clear idea about this study, a background analysis is conducted and basic knowledge about the subject is presented in this section.

2.1 Enterprise Resource Planning (ERP)

In the 1980s, several industrial and utility companies implemented information technology (IT) across the board, from mechanical sectors to department of customer care, and at wholly points. In numerous companies, Information technology application provided a competitive advantage by factorizing (dropping risks and uncertainty in the environment and creating opportunities), exploiting hidden assets, motivating innovations, and encouraging subsistence dispositions in contrast to pressures from innovative competitors that be able to violence or even dismiss a fresh industry (Henderson et al., 1999).

Over the 1990s, the focus shifted from individual function IT support to the combination of wholly structures in totally purposeful regions. Material requirements forecasting in production was combined with other applications in services such as efficiency, servicing, marketing, distribution, accounting, infrastructure, finance, human resources, and project management in Enterprise Resource Planning systems the whole range of activities carried out by a business (Gupta, 2000). Enterprise Resource Planning systems, also known as computer-based information systems for business collaboration, are a set of interconnected programs that share a database (Hwa Chung & Snyder, 2000). Enterprise Resource Planning systems is a company-wide management framework that aims to reduce costs and inventories while also boosting efficiency and customer experience.

Enterprise Resource Planning systems basically integrate inventory data with monetary, revenue, and workforce data, enabling businesses to market their goods, generate financial statements, and efficiently control their human, material, and financial resources, only we

can get full advantages from Enterprise Resource Planning systems while it apply independently and entire business re-engineering process is followed. (Curran & Ladd, 1999). Enterprise Resource Planning systems protections infrastructure aspects such as server scattered manner, database management system (RDBMS), and object-oriented programming in addition to system requirements (Markus et al.,2000). What is Enterprise Resource Planning systems and what does it mean? The first step in attaining the study's goals is to properly define Enterprise Resource Plan. These systems are highly sophisticated, and because they lack a defined meaning, different organizations can interpret them differently.

According to Ohlsson & Ollfors, (2001) Enterprise resource planning can be defined as “A computer system that helps international businesses manage their information flows.” It has been further clearly defined as a system that can “reduce management information system (MIS) financial monitoring, ordering, and service costs, and contribute to more sensible monitoring and processing of revenue, consumer, and total data (Wagle, 1998).

Enterprise Resource Plan was designed and applied as a planning tool in the heavy manufacturing industry. Through using forecast sales, the initial systems, known as Material Requirement Planning (MRP), is used to optimize the effectiveness of purchasing and controlling the inventory of materials needed for manufacturing processes (Laudon and Laudon, 2007).

Materials Resources Planning systems were transformed into Enterprise Resource Plantings as information technology progressed, warehousing, procurement, quality management, procurement, financials, human resources, sales department, and electronic commerce, allowing them to combine both front and back office functions. Wide companies have traditionally used such type structures to process materials at various levels of project execution in the building industry. (Bell & Wootten, 1985).

Enterprise Resource Planning systems adoption and utilization have not yet achieved the same level as in other industrial sectors due to the decentralized structure of the construction industry. The construction segment has just accepted the advantages of Enterprise Resource Plantings, while being behind other large scale manufacturing that have been implementing them to improve their efficiency and root levels. Large

construction companies are adopting digital technology to boost their profits at a far faster rate than in the past. Academics have been interested in analyzing Enterprise Resource Plantings since IT expenditures are a substantial financial commitment for a firm.

2.2 The Cloud Enterprise Resource Planning systems

Cloud computing is becoming more widely available, and companies have increased turning to suppliers that can store critical company data on the cloud. Cloud-based Enterprise Resource Plan has grown more prevalent in recent years as a result of this, as well as vendors' belief that the cloud is the best place to house all future computing systems. (Consulting Panorama, 2015).

Cloud-based Enterprise Resource Plan can be executed in a variety of ways and with different degrees of responsibility. The first alternative is to use a Software as a Service (SaaS) approach. This guarantees that the cloud provider manages everything from servers to network infrastructure, hardware, and software. All that remains for the company to do now is configure the service and pay for it. Many SaaS applications are hosted on a heterogeneous distributed cloud architecture, which allows for several implementations to be launched and hosted on the same hardware and infrastructure. Instead of running on separate virtual servers, each implementation would be isolated from the others within the system. (Degree et al., 2017).

Another kind of implementation is cloud hosted, in which the system vendor is responsible for the hardware, software, and resources. The client will be accountable for ensuring the internal networks are fully operational, as well as the application. This provides the customer with more customization options. Since this approach can be used in a single-tenant environment, the infrastructure will be run on separate virtual machines, with the database on its own cloud (Degree et al., 2017).

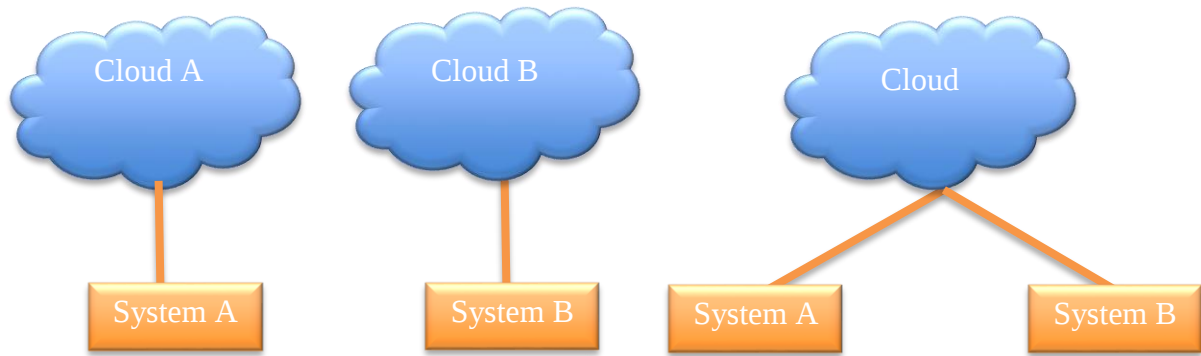


Figure 2: Cloud ERP vs. SaaS ERP (Degree et al., 2017)

Using a cloud Enterprise Resource Plan system rather than an on-house Enterprise Resource Plan system has several advantages. The first advantage is that the company would not need to invest in hardware to have a fully functional system. Installing the gadget, as well as assembling and configuring databases and servers, takes time. A cloud ERP system may be up and operating even faster because the hardware and core system are already installed. Before the system may be utilized, only company-specific setups and modifications need time to build. (Degree et al., 2017).

Another advantage of cloud Information system is the ease with which it can be implemented. Cloud companies must constantly expand their data centers in order to hold the additional data that comes in. Customers may also extend their Enterprise Resource Planning systems by adding more virtual computers to enhance bandwidth or upgrading data storage to handle more data. This gives companies the flexibility to scale up or down the system based on their needs. This is beneficial to small and rapidly growing businesses because they can tailor the device to their needs without having to purchase and upgrade new hardware. Because of the compensation scheme, this is a really positive idea because a business never has unused hardware (Degree et al., 2017).

It would also be less difficult for Enterprise Resource Planning systems vendors to keep their services up to date. Providers can upgrade the main framework for all users at once, and everybody can immediately access the upgraded version (Degree et al., 2017).

The fact that all content will be handled in a supercomputer far away from the business might also be a problem. For all of the organization's data, the cloud service must be trusted. Because the data is expected to be protected on the cloud, the cloud provider is likely to have a substantially greater security budget than other businesses. Some types of data must be handled in the same nation as the business, which can be difficult because cloud firms do not have data centers in every region. (Degree et al., 2017).

2.3 Different vendors of Enterprise Resource Planning systems

Various vendors are developing Enterprise Resource Plan software on their own. The majority of companies have integrated cloud computing into their existing systems, and others are completely reliant on cloud deployment in future releases. Then there are companies that have already moved their operations to the cloud. The biggest players in the market, SAP, Oracle, and Microsoft, as well as Infor and NetSuite, are all Tier 1 suppliers.

SAP is the industry's largest vendor of Enterprise Resource Plan software, while Oracle is also a prominent participant. Microsoft owns a sizable chunk of the market. Because the most complex software is created and maintained by global businesses, it necessitates a significant investment of resources. Several middle market vendors, like as Sage and Infor, have a significant portion of the industry. Many of the Cloud based techniques were pioneered by middle market firms, and these providers expand quickly because they dedicate time and money in research and development. NetSuite is a provider that has a small market share in the Enterprise Resource Plan sector as a whole. However, it is a cloud Enterprise Resource Plan company with a substantial market share; in fact, according to their own data, they are the largest cloud Enterprise Resource Plan vendor. (*Cloud ERP Software Solution | NetSuite*, n.d.).

2.3.1 SAP

SAP has long provided comprehensive enterprise resource planning solutions to businesses and organizations. SAP R/3 was the previous name for it, however it has since been renamed SAP HANA S/4. SAP S/4 HANA is the company's most dynamic ERP system,

and it's based on HANA, a relatively new database technology. This is an in-memory database technique that maintains a piece of the data near to the user in order to decrease the amount of time it takes to search up information. (*Digital Transformation: Future-Proof Your Enterprise*, n.d.).

The SAP S/4 platform, which comprises application and database servers, is based on the HANA platform. On top of this platform, SAP's different program modules are installed, followed by the client GUI. SAP has a number of modules for many elements of a business, including finance, human resources, supply chain management, sales, and marketing. (Sap, 2014).

2.3.2 SAP HANA

SAP has created a more in database platform for usage in a variety of applications, as well as a cloud architecture based on it. The platform is known as HANA. This platform maintains data in memory, moving closer to the customer's CPU and reducing data transit between client and database, resulting in decreased latency. (*SAP HANA Platform - SAP Help Portal*, n.d.). The client can deliver real-time data in memory because it can memorize to the database in the background rather than when the user requests it.

2.3.3 SAP Cloud

SAP S/4 HANA is based on the HANA platform and is accessible as part of SAP's enterprise cloud infrastructure. This cloud architecture is spread over four various servers, each with its own set of security measures. All server farms are equipped with alternative power sources and an extra charge in the case of a shutdown. Both data centers are now supervised 24 hours a day, and anybody who wants to access them must first be approved with an ID card or, in certain circumstances, biometric scans. (SAP Data Center | SAP Trust Center, n.d.).

2.3.4 Oracle

Oracle is also one of the leading providers of Enterprise Resource Plan systems, having long provided customers with both simple and complex solutions. They've also released a cloud-based Enterprise Resource Plan framework recently. Oracle Fusion Application, a

business suite that will ultimately replace Oracle's old, complex, and resource-intensive E-Business suite, includes an Enterprise Resource Plan framework. (Kevin Hwang, 2011).

This cloud Enterprise Resource Planning solution is comprised of several modules, each with its own set of features, allowing the device to be readily tailored to the demands of a given business. There are numerous modules accessible, including financial, project management, accounting hub, and others. Oracle's Cloud Enterprise Resource Plan (CERP) is a software as a service (SaaS) application that assures Oracle manages almost every part of the system. (Enterprise Resource Plan (ERP) | Oracle, n.d.).

2.3.5 Oracle Fusion

Oracle Fusion Applications is a brand-new Enterprise Resource Plan solution that is not a replacement for any of Oracle's current Enterprise resource planning. Consumer demand for new and improved software prompted the development of this type of Enterprise Resource Plan system, as well as a need to stay up with other suppliers in terms of public cloud deployment. Oracle Fusion provides on-premises, private cloud, public cloud, and hybrid deployment options for this technology stack. (*Pro Oracle Fusion Applications: Installation and Administration* - Tushar Thakker - Google Books, n.d.).

Oracle Fusion is divided into two sections, Fusion middleware and Fusion application, as well as a database to store it. It's a standard-based architecture, which means it'll be simple to adjust to new developments and replicate existing structures. It allows consumers to modify almost everything, including the user experience, business processes, and business logic, in a simple and flexible manner (Bagal et al., 2012).

2.3.6 Oracle Cloud

Oracle's own Cloud service is built on Oracle's numerous products, particularly the Oracle database. They have 19 data centers worldwide, all of which are monitored 24 hours a day, seven days a week. Places offers a Cloud Machine, which is a platform for deploying Oracle Cloud in a company's own private data center. By keeping their data on-premises, businesses may reap the benefits of a cloud-based platform. Oracle is also in charge of the system's deployment and upkeep. (Cloud Infrastructure | Oracle, n.d.).

2.3.7 Microsoft

Microsoft's Dynamics AX is an Enterprise Resource Plan framework. Microsoft just introduced a new edition of Dynamics AX that is cloud-based and hence differs in terms of user experience from prior versions. Microsoft Dynamics AX is made up of a number of modules and categories that can be chosen based on the company's requirements. Finance, commerce, information technology, and operations are just a few of the modules available. Because all of these modules are so extensive, the system may be set up to just use the capabilities that the business requires. It might also be determined by the industry in which the firm works.

Because Microsoft already has a number of well-known applications, Dynamics AX has the same look and feel as the Office programs, and importing and exporting data and files from Dynamics AX to the Office programs is likewise quite straightforward. (Degree et al., 2017).

2.3.8 Microsoft Technology

Everything is based on internet protocols since everything is meant to function on the internet. The HTTPS protocol is used to transport all messages and requests between the client and the server. Because the entire framework is web-based, all that is required to use it is a web browser. All Microsoft core code is included in the deepest layer, SYS. Which layer a developer saves their changes is depend on whether they are a Microsoft developer, a partner developer, a third-party developer, or the customer's own developer. (Luszczak, 2019).

2.3.9 Microsoft Azure

The company's network bandwidth, Microsoft Azure, is based on a worldwide network of service centers. Microsoft has data centers across the world and can supply almost any cloud computing service. They have a user base of over a billion people and run 24 data centers. In order to expand their data centers comfortably, they use server and cooling system modules. Each data center has a high-speed fiber network that connects it to other data centers. (Cloud Computing Services | Microsoft Azure, n.d.).

2.3.10 Infor

Infor is one of the first companies to offer a cloud-based solution and has a large market share among vendors. This is one of the most popular cloud services since it is hosted in the cloud in partnership with Amazon and leverages their data facilities. They justify this by stating that they would rather spend more time and effort enhancing the application and framework than the infrastructure. (Resources | White Papers and Infographics | Infor, n.d.).

Infor Cloud ERP is known as Cloud suite, and it comes in a variety of variations that cater to all categories of enterprises. This architecture is built around complete packages that are tailored to each form of enterprise, rather than templates like many other cloud ERP systems. Companies must hold the method of best practice applications, which may not be ideally suited to the industry but are, in most cases, similar to it (Global Infrastructure, n.d.).

2.3.11 Infor ION

By processing and routing XML documents, this architecture is built on a publisher and subscribing module. This design is based on the internet, where a large number of web servers host a limited percentage of all websites on the internet. In ION, the same method is used (Resources | White Papers and Infographics | Infor, n.d.).

2.3.12 Amazon Cloud AWS

The Infor Cloud Suite ERP framework is hosted on Amazon's cloud infrastructure. With 33 datacenters in 12 different regional locations, Amazon is one of the most excellently cloud providers. Amazon AWS is divided into many regions, each of which is located in a different area of the world and has a number of distinct availability zones connected by low-latency links. (Global Infrastructure, n.d.).

2.3.13 NetSuite

NetSuite is a popular cloud Enterprise resource planning company that provides a straightforward Enterprise resource planning solution. The company's Enterprise resource planning has always been available on the cloud, and it was the first big system to do so. They also offer One World, a business suite that includes Enterprise resource planning and

other modules and focuses on being global and flexible for large businesses. NetSuite includes modules for financial, supply chain, and inventory control, as well as order and billing management, among other things (Cloud ERP Software Solution | NetSuite, n.d.).

Suite Cloud is a NetSuite component that serves as a forum for development software. It provides graphic and workflow customization software. It also includes a service for integrating the system with an on premise system already in place at an organization. This is a web service that allows for convergence of a variety of programming languages, including Java, Microsoft.NET, and others. It also deals with REST full structures. NetSuite also has a specialized option for businesses that use SAP or Oracle, in the form of a connector (NetSuite Platform - Suite Cloud: The Ultimate Business Cloud Platform, n.d.).

2.3.14 NetSuite Cloud

The cloud Enterprise Resource Planning systems infrastructure of NetSuite is housed in its own data centers in California and Massachusetts, respectively. To prevent mistakes, the data centers have a number of protections in place. They have a backup of all data that can be used if one of the data centers fails and the service remains operational. If one of the data centers fails, the data from the other data center will be recovered. Both data centers feature three internet connections into the center, allowing the data center to function even if two connections break at the same time. NetSuite employs round-the-clock security methods like as video surveillance, ID access codes, and biometric identifications to ensure that the data centers are physically safe. Users can only see data through an application; they do not have direct access to the database in NetSuite's apps, which utilize 128-bit encryption for user authentication. (NetSuite Data Center, n.d.).

2.4 The Sri Lankan Construction Industry

Sri Lanka has seen an increase in construction investment as a result the nation's economic developments over the previous decade. This resulted in substantial changes, particularly in the construction industry's supply chain. Government policies, according to predictions for the new century, will be the most significant unpredictable factor, with the government's

traditional role in construction shifting from investor and regulator to facilitator. While these policies have boosted private sector engagement in infrastructure and industrial growth, they have also put domestic industry under pressure to adapt as a result of these advances. As a result, contracting companies' roles, as well as the project delivery process and project procurement, will alter to suit new demand circumstances. This new project culture will encounter several challenges arising from local financial, technological, and managerial shortcomings, requiring construction industry expansion to accommodate new trends in order to be beneficial (Wedikkara & Devapriya, 2000). In the construction sector, supply chain management is a crucial instrument for regulating business operations in a defined and systematic manner to improve quality, time management, and profit. (Gunawardana & Wedage, 2020)

2.5 Construction Materials Management

Material planning is a strategy that includes planning of material demands, purchase of materials, identifying and evaluating suppliers, ordering, shipping, transportation, receiving materials, stockpiling, redistribution materials and even financing (Bell & Wootten, 1985). Those participating in this dynamic era must effectively collaborate and work together. This is why material management schemes assistance from information technology implementation.

Material management systems are used by many construction businesses to store, organize, integrate, and reproduction facts archives relating to materials requisitions, ordering, vendor assessments, and warehouse inventories. (Bell & Wootten, 1985). The objective of the corporate resource plan concept is to integrate material planning systems with various computer systems to conduct operations such as design, planning and accounts, and to reduce costs and speed up the handling of documents. The information management system and electronic communications are multiple information innovations that have been deployed (Elzarka, 1995).

2.6 Construction Enterprise Resource Planning Systems

The construction sector can benefit from enterprise resource planning systems in a diversity of ways. Many construction companies realize the benefits of using an Enterprise resource planning system, but they are hesitant to do so owing to the high cost, unpredictability, and risks. Construction firms have various problems in managing project timelines, finances, safety, and quality to fulfill the owner's and/or architect's criteria. Appropriate use of internal and external resources is critical for construction businesses to make the best business decisions, achieve corporate goals, and thrive in a competitive climate. (Shi & Halpin, 2003). Several big construction companies have lately begun to use enterprise resource planning systems, an integrated information technology clarification, to better combine diverse business activities and resources, especially those connected to project accounting methods and practices. While Enterprise resource planning systems vary by industry, their basic premise is centered on information standardization and coordination, which leads to greater efficiency. Enterprise resource planning solutions offer a variety of benefits, including synchronizing operations and information, lowering carrying costs, shortening cycle times, and enhancing customer involvement. (Maas, 2000).

All areas in which R/3 project implementing function areas are unhappy are too many financial purchase regulations, failure to estimate the additional cost, insufficient functioning of development work, budget preparation defects, an incomplete process for clarifying the per cent, and the computation of the complete portion of the finished work.

In an analysis of R/3 software generated by O'Connor & Dodd (2000), R/3 has fifteen numbers of functions, all of which are incomplete to a certain degree or another. These include capture of price of unit, reports for cost, Facility period projecting and a labor cost survey, cost tracking for change orders, job breakdown structure style, timetable for the conceptual/milestone phases of the project, detailed network of activity precedence, project schedule reports, planning in short intervals, creation and issuance of purchasing orders, and so on. Change orders, back-charges, and redesign, contractor retention management, and tracking and documenting the physical completion % are all being tracked. Controlling warehouse inventory and rearranging warehouse goods are two important tasks.

2.7 Basic Features of the Construction Enterprise Resource Plan System

2.7.1 Project oriented.

The construction industry's undertakings are the underpinning. Each assignment is an accomplished achievement that must be completed in a timely and budgetary way. The cost for the delivery of the product is typically set after the contract is entered into and the project profit is completely determined by the cost, which will then be based on the reliability of the on-site operations. A Construction Enterprise Resource Plan system should be able to control current programs by investigating and projections success, expense status, revenue growth, and future issues like being behind schedule and surpassing overhead costs, allowing remedial choices to be taken before problems arise. Furthermore, a project's profitability and success have an impact on the organization's business effectiveness. To estimate the organization's business position in terms of finance, financial position, buying, machinery, and human capital, review project indicators must be compiled and presented to the top management on a regular basis. (Shi & Halpin, 2003).

2.7.2 Integrated

A conventional construction company's front office has two functions: operations and estimates. Accounting, engineering, contracts, procurement, and buying are just a few of the back-office tasks. These front and back offices share information and make decisions together regarding current projects and future business prospects. To achieve great competence and mechanization, these departments should be linked in an integrated system. The platform has to include the information about the organization and each sector must include appropriate accessibility for its operational objectives to about the same system. Any firm can obtain electronic knowledge to decide the management it requirements, and any department may improve its own databases and make decisions that are then made available to the public for other departments. (Shi & Halpin, 2003).

2.7.3 Distributed and parallelized

Managers in several offices within a company take on multiple administrative responsibilities at once. As a result, a combined Enterprise resource planning system must employ equivalent and dispersed technology to accommodate numerous contemporary applications or requests. Managers in several offices within a company take on multiple administrative responsibilities at once. As a result, an integrated Enterprise resource planning system must employ parallel and dispersed technology to accommodate numerous concurrent applications or requests. (Shi & Halpin, 2003).

2.7.4 Open and expandable

It is common knowledge that each construction firm has certain features that are important to its success. The applications might be rather different from one company to the next. Due to its open and flexible design, a company may tailor its necessary applications to meet its business demands. Meanwhile, new applications may be installed and those that are no longer needed can be taken out of the environment. As a consequence, the ultimate client must make a great degree of customization with minimum work. (Shi & Halpin, 2003).

2.7.5 Scalable.

All enterprise resource management solutions need to be accessible. Executing an Enterprise resource planning systems system involves a large financial investment as well as business process reengineering. An Enterprise resource planning system must be able to sustain a company's future development for a number of years. Scaling reflects the system's requirement for more management positions. The operational offices of a building firm are dependent on the foundation and the scale of the enterprise. (Shi & Halpin, 2003)

2.7.6 Accessible remotely

Every development is developed on a different site, It might reach the office of the leadership hundreds and even thousands of km. Remote monitoring provides project managers and other website employees with access to centralized resources such as purchase and financing information and helps higher managers to measure project performance and its effect on the enterprise. The company headquarters is provided with updated status of the project data. (Shi & Halpin, 2003).

2.7.7 Transparent

There is a continuous history of mechanical progress in the construction industry. One successful method for addressing this problem is to include a self-explaining process in the system that lets users find appropriate reasoning for the system's decision making. For example, the system can request that The site works for a projects under its supervision are rescheduled by the project manager (PM). “The essential material is not accessible because Worldwide Supplier is unable to provide the item as anticipated, as a result of the buying department's altered distribution instructions," the rationale might be stated. (Shi & Halpin, 2003).

2.7.8 Reliable robust

This is a characteristic that must be present in any decision-making system. For example, to validate estimating, reliable scientific expense records must be collected from the cost record; a procurement direction must be checked and accepted in the proper order; and A construction reserving tool application must be properly managed and a booking made or, in the event that a requirement cannot be met, an applicant must be advised. (Shi & Halpin, 2003).

2.8 Construction Enterprise Resource Planning System Architecture

Every system can be classified on the basis on the architecture used, and there are a few techniques that are more widely used than others, as well as a few architectures are widely used by the largest providers on the market. The most common systems use 2-tier and 3-tier architectures, with the aim of supporting a large number of concurrent users while maintaining good performance. A subscriber/publisher module is often used by one of the most common schemes on the market.

Ahmed et al., (2003) presented a multiple design in construction businesses to apply enterprise resource management infrastructures, as seen in Figure 3.

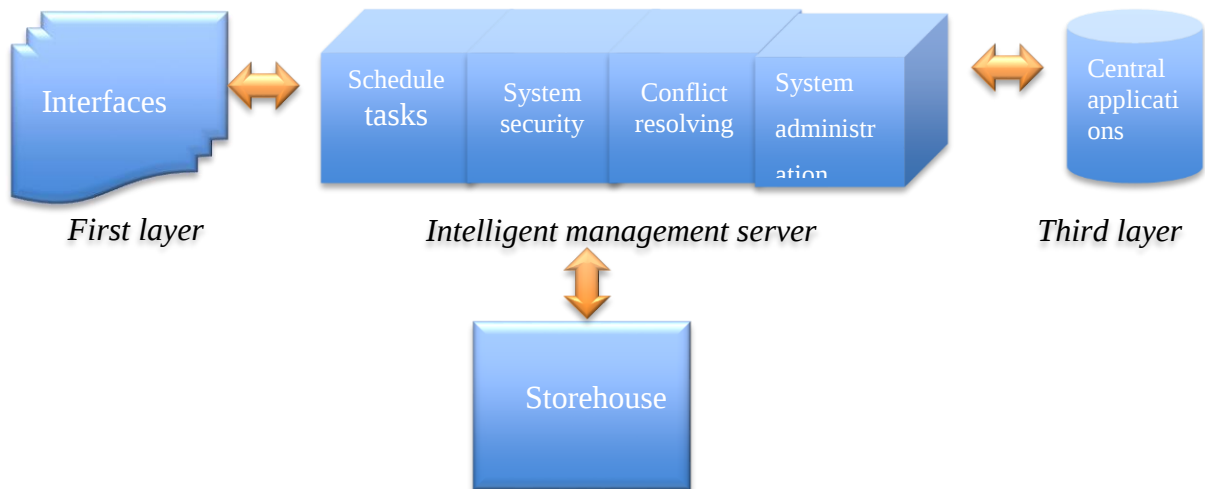


Figure 3: A multiple tier ERP building structure (Shi & Halpin, 2003)

2.8.1 First Layer - Operator Interfaces (Customers)

The main purpose of the very first layer is to provide many customers with connections on the inside of a construction company. Wages, finance and accounting, personnel relations, procurement, infrastructure, project governance, approximation and building, and organizational management are part of the user classifications. Whenever the users enter the platform, the user is allocated a leadership position and has entry to a dashboard to execute its administrative tasks. The second level is responsible for the planning and

implementation of technical specifications, while the third layer is responsible for the overall management of expected duties. A first stage with the consent of the management group Customers can implement specific applications in their own surroundings and minimize unnecessary connection.

2.8.2 Second Layer - Supervision Server

The platform processor is the computer that offers enterprise governance and centralized analytics for customers and developers. It symbolizes the relationship between users and apps. Between the two worlds, process modules act as a link. A process module is a collection of coordinated management actions used to achieve a certain management goal. A relevant process module will be found and run when a request is submitted. While a process module is operating, management tasks can invoke apps. Enterprise resource planning systems already, a library of standard process modules based on industry and business best practices is available (Jacobs & Clay Whybark, 2000).

2.8.3 Third Layer - Applications

The main repository and the creation of a third phase. A basic database holds accounting information, planning data, machine information, and other business information. Knowledge management is a modern innovation that makes it possible for a complete enterprise to gather data particular topic, integrated, non-volatile and time-varying (Inmon, 2000).

It's important to note that a construction company's data varies from that of a manufacturer. There are 3 major types of construction applications:

1. Business level Application
2. Development level Application
3. Back office Application

Business level application are primarily used to schedule corporate capital, establish Different Project Application Approaches, determine marketing strategy, defining a

promotional plan, establishing a company's administration and commercial approach and giving management techniques to the corporation. Instances of implementations at process level include cost estimation, programming, organization, allocation of resources, performance and supervision and good manufacturing practices. Examples of back-office applications include human resources management, procurement, warehousing, reporting, financial and property managerial staff.

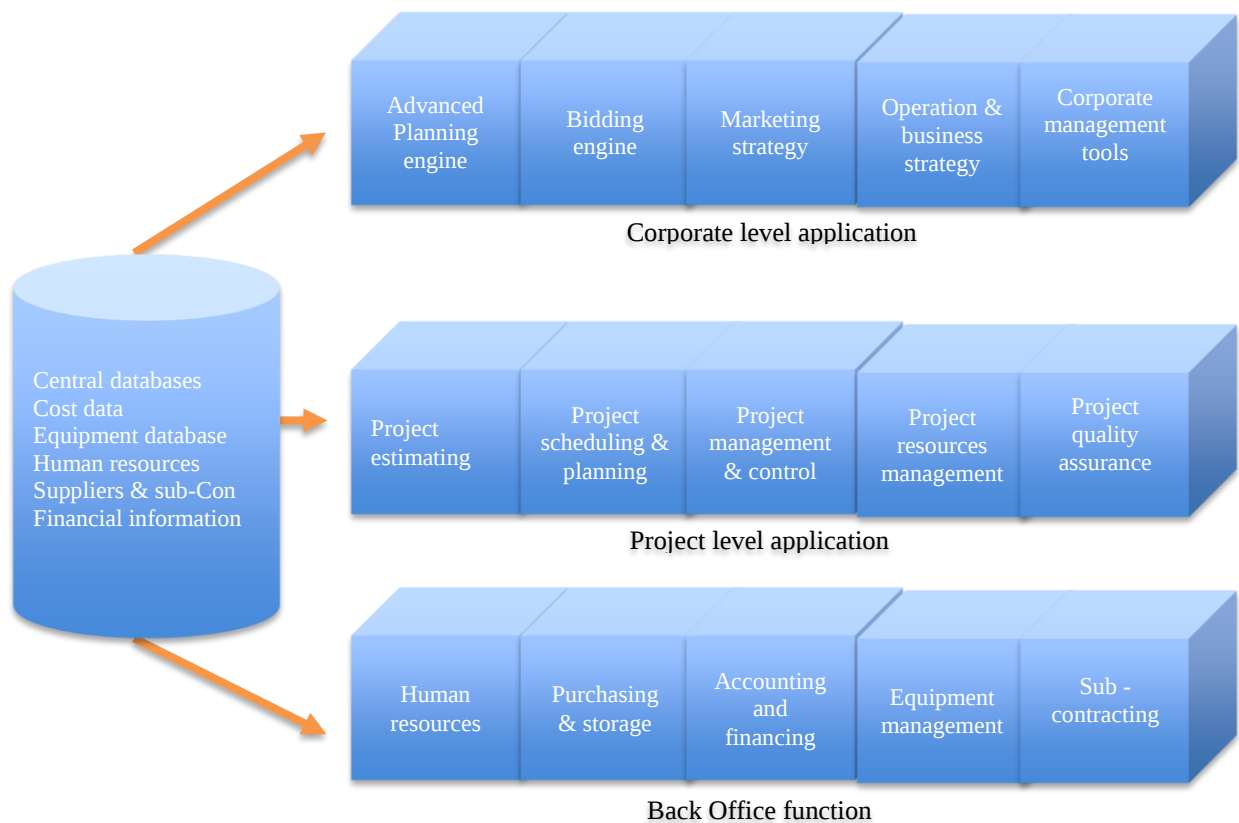


Figure 4: Organization of application in third tier (Shi & Halpin, 2003)

2.8.4 Use of enterprise resource planning in the construction sector

As mentioned above, the human component is one of the most significant aspects affecting the implementation of business resource planning. Abdinnour-Helm et al., (2003) show that engagement in pre-implementation is essential for a good approach to the ERP. Various articles examine the influence on the efficacy of the application of cultural variables. Jones et al. (2006) propose a case study on many sites that shows how a similar culture facilitates information sharing during ERP deployment. Moon & Moon, (2007) believe that national culture is a significant component in multi-national environments. Amoako-Gyampah & Salam (2003) concur that common values may simplify system implementation by improving system acceptability. Lander et al., (2004) Consider a crucial component in the implementation process to build the belief amongst team participants and other relevant stakeholders. Botta-Genoulaz et al. (2005) suggest that the effect of corporate social issues is viewed as a crucial part of the process, as well highlighted by Yusuf et al (2004).

2.9 Enterprises of small and medium scale (SMEs).

Amongst the most important areas in international socioeconomic expansion is small and medium-sized enterprises (SMEs). In different countries, small and medium-sized construction companies may differ. There is no agreed definition of small and medium-sized enterprises, according to a literature research. They are characterized in a variety of ways, but the most often used criteria are yearly sales turnover, staff count, and/or investment amount (Bauchet & Morduch, 2012). For example, in the Member States of the European Union (2020), the European Commission is a well-defined micro, small and medium-sized business, with less than 250 employees and annual revenues of no greater than 50 million euros, or an annual balance sheet of no more than 43 million euro. (DocsRoom - European Commission, n.d.).

In certain developing countries, such as China and Malaysia, small and medium-sized construction companies are defined based on yearly sales turnover, the contractor's bidding capability, or compensated capital (Kamal et al., 2014). In Taiwan SMEs (2021) are defined

as companies with paid-in capitals of NTD 80 million or less (USD2,42 million), or less than 200 full-time workers, and are under a mix of small and medium-sized buildings and buildings (2021) (Kamal et al., 2014).

Small and medium enterprises in the Sri Lanka contest are complex to describe so even though there are multiple classifications of company assets, employees, capacity, investments, cash flow in domestic and international markets, complexity, innovation, efficiencies, options for better development and no single definition is currently accepted at national level. The following table shows that generally available definition of Small and medium scale enterprises in Sri Lanka. Nearly all such categories recognized as employee numbers, overall equity and turnover their key criterion (Dasanayaka, 2006).

Table 1:- In Sri Lanka, definitions for Small and medium enterprises (Dasanayaka, 2006).

Organization	Benchmark	Medium Scale	Small Scale
Sri Lanka Standards Institution (SLSI)	Numbers of Workforces	Between 50 and 249	Less than 50
Industrial Development Board (IDB)	Worth of Equipment	Between Rs 4 million and 10 million	Less than Rs 4 million
Ministry of Industry, Tourism and Investment Promotion	Worth of immovable properties other than land and buildings	Up to Rs 16 million	Less than Rs 16 million
Federation of Chambers of Commerce and Industry of Sri Lanka	Investment engaged	Between Rs 2 million and 20 million	Less than Rs 2 million
Ministry of Small and Rural Industries	Entire Investment	Between Rs 20 million and 50 million	Between Rs 1 million and 20 million

Ceylon National Chamber of Industries	i) Worth of properties other than buildings and lands	Between Rs 4 million and Rs 20 million	Less than Rs 4 million
	ii) Numbers of Workforces	Between 10 and 50	Less than 10
Sri Lanka Export Development Board (EDB)	i) Capital investment excluding lands and building	More than Rs 40 million	Less than Rs 20 million
	ii) Annual export turnover	More than Rs 100 million	Less than Rs 100 million
World Bank (for Sri Lankan country studies and loan programs)	Numbers of Workforces	Between 50 and 99	Less than 50
Dept. of Census and Statistics	Numbers of Workforces	More than 25	Less than 25
Task Force for SMEs Development in Sri Lanka (2020)	Asset worth excluding land and buildings value	Not exceeding Rs 50 million	Not exceeding Rs 20 million
Sri Lankan Apparel Industry, Task force on five - year strategy (2020)	i) Export worth	Rs 101 million to 250 million	Rs 0.25 million to 100 million
	ii) Numbers of Workforces	Between 101 and 250	Between 1 and 100
Dept. of Small Industries	i) Investment investment	Between Rs 5 and 25 million	Less than Rs 5 million
	ii) Numbers of Workforces	Between 50 and 100	Less than 50 employees

2.9 Importance of Enterprise resource planning systems in small and medium-sized enterprises.

The following is a list of the most essential reasons for contributing to an ERP deployment that are frequently cited.

- Connectivity
- Information Action
- Standardization and process Improvement
- Business Consideration
- Dissatisfaction with outdated legacy system

Connectivity has been identified as the most essential aspect mentioned as a key reason for using Enterprise resource planning system by many organizations. Many businesses see enterprise resource planning systems as a tool for integrating front and back office operations onto a single platform. A research was conducted by (Ragowsky & Somers, 2002) according to the report “In terms of frequency of comparison in both technological and organizational dimensions, integration was the Only one reasoning most crucial,” says the report.

In a subsequent investigation, the need of incorporation for reasons of acquisition was emphasized Ragowsky & Somers, (2002), JW Ross, (1999); Alvarez, (2000) and Negahban, (2008) also described as an Integration was key problem in ERP adoption (Ragowsky & Somers, 2002). The adoption of a single platform or software product enhances ease of access by providing a user-friendly environment where employees can rapidly access critical information. Connectivity is thought to help an organization's cooperation purpose.

As a bonus, the correct installation of an Enterprise Resources Planning systems leads in improved access to accurate data. Enterprise Resources Planning provides unlimited access to current statistics and, because of their accuracy and ease of use, hey may be utilized to ensure the development of numerous operations in a company.

A research was conducted by Ragowsky & Somers, (2002) As a result of greater access to information, corporations anticipate better network connection. Information sharing access

accounted for around 16 percent of all rationalization claims for Enterprise Resource Plan development, according to the same research.

Consistency and process optimization are two additional important reasons for using Enterprise Resource Plan. The majority of businesses that have deployed an Enterprise Resource Plan framework previously used an inefficient legacy system. The adoption of an Enterprise Resource Plan system may be utilized to address issues with older legacy applications as a platform. Reengineering corporate processes is also possible using Enterprise Resource Plan solutions.

The organization is introduced to new processes, which must be followed. This procedure spans across divisions and broadens the extent of an employee's abilities. The fitting of an enterprise resource planning system generally provides uniformity in the organization, reducing any inefficiencies caused by different understandings. Botta-Genoulaz et al., (2005) according to the study, Connectivity of Enterprise Resource Plan procedures with a business process has been investigated by a number of academics as a crucial phase in the deployment process. M Daneva, (2004) defines in terms of concentration and validation, the issue of process alignment, Standard Enterprise Resource Plan capacity is evaluated to determine how effectively the procedure and information demands of the company are fulfilled once a wide array of business systems and information requirements are developed.

Enterprise Resource Plan adoption has also been influenced by business concerns. Organizations have had to modify their operations to accommodate for the new conditions brought about by various communities and geographic locations due to the worldwide character of today's industry. Due to the adoption of Enterprise Resource Plan, these businesses will now be able to operate internationally and provide their goods and services at the lowest feasible rates. Their revenue has increased significantly as a result of their market's expansion. Other commercial factors that have been considered by businesses include preserving customer base and increasing competition. Regrettably, contemporary research contradicts this finding, as indicated by Negahban, (2008). According to a survey of five numbers of manufacturing companies, Yen & Sheu, (2004), Examine the connection between Enterprise Resource Plan implementation processes and a company's

strategic orientation, and ensure that Enterprise Resource Plan implementation should be in line with the company's strategic plan, with specific recommendations. Hunton et al., (2003) Investigators were able to establish the result and discussion of Enterprise Resource Plan adoption on organizational effectiveness by comparing organizations that had adopted it to those that had not. Although Enterprise Resource Plan allows for major advances in relationships, social structure, and attitudes, which may be important factors of comparative strategy in the information ecosystem, the structures and environments best suited to achieve this level of transformation are incompatible with Enterprise Resource Plan standards.

2.11 The benefits to small and medium scale construction companies for enterprise resource planning.

What are some of the anticipated benefits that encourage firms to invest in Enterprise Resource Plan implementation? Botta-Genoulaz et al., (2005) There are two main study streams, according to the literature. The first looks at the fundamental organizational capabilities that support Enterprise Resource Plan as a tactical concept, while the second looks at the mechanics of executing an information system, including their respective achievements and expenditures. As shown by (Chen, 2001) "When a company understands that its present business processes and procedures are insufficient to fulfill its current and/or future strategic objectives, it begins to plan for Implementation process." The operating environment of Small to Mid-Sized Construction Companies is changing as a result of a variety of external and internal pressures, and their methods are becoming "incompetent." A more thorough study of the possible advantages is required to convince Small to Midsized Construction Companies to utilize Enterprise Resource Plan. A thorough assessment of the available literature was undertaken with the objective of identifying and categorizing possible advantages. Benefits in this sense are acts that stimulate enhanced organizational performance and more income from operations. Benefits from information technology investments that are dependent on processes are usually divided into three groups, as indicated by Andresen, (2001) Productivity, effectiveness, and success are all common advantages. The following are some of the benefits of implementing Enterprise Resource Plan in the context of Small to Mid-Sized Construction Companies.

1. Improved customer-relationship responsibilities
2. Supply chain collaborations which are more reliable
3. Increased corporate adaptability
4. Capabilities for making better decisions have improved.
5. A reduction in the time and cost it takes to complete a project.
6. The corporation has the opportunity to reengineer and modernize its business processes.

The above advantages may be divided into two different categories of advantages: direct and indirect. As indicated by Murphy & Simon, (2002) The distinction between products and services can be traced to the different handling of tangibles and intangibles. As indicated by Murphy & Simon, (2002) The distinction between products and services can be traced to the different classification of tangibles and intangibles. Goods were material that could be deposited as early as Adam Smith, while commodities were immaterial and transitory. Services could not be listed as investments due to their transient value, but goods could. Items which have been counted as investments must, by definition, be tangible. Remenyi et al., (2007) stated that A direct benefit is one that has a significant impact on a company's profitability;

however, many investments in today's economy are intangible, and these investments provide better income, which translates to more productivity and savings. An identified non-monetary asset, without any physical form, kept in accordance with international accounting standards, for the production or supply, of products or services or for rental to others for administrative reasons (Buianov, 2015). Intangible benefits arising from ERP implementation are impossible to quantify. Dan Remenyi & Sherwood-Smith, (1999) stated that, there are seven main ways in which IT might give companies with immediate payoffs. They further suggest that active systems have intangible benefits that are difficult to quantify.

Patel & Irani, (1999) The challenge of assessing IT projects in a changing context, particularly when intangibles are considered, was highlighted. Tallon et al., (2001) Several investigations have shown that economic and monetary measurements fail to correctly identify the payback of IT initiatives, and that executive perspective is one means of

measuring merit. They emphasized on the practical adaptation and support of IT initiatives, but also emphasized that professors must understand how they may successfully understand and communicate the immaterial benefits of IT. Giaglis, (2014) discussed in their estimation of information system assessments, Difficult factors were discovered related with descriptive (unquantifiable) advantages.

Investments in Enterprise Resource Plan systems have been explicitly labeled as strategic. The overall goal, according to the literature study, is to increase income, reduce production costs, decrease lead times, and maintain relationships with customers. According to a survey conducted by Smith & Steadman, (1999) After comparing verified cost profitability and revenue growth with system installation and maintenance expenditures, companies have estimated the worth of \$1.5 million. Over a three-year cycle, the use of the Enterprise Resource Plan tools produced substantially higher returns on assets, income and asset volume than prior studies have shown (Hunton et al., 2003).

2.12 Difficulties with implementation of enterprise resource planning by small and medium scale construction organizations.

The deployment of an effective strategy for corporate resource planning is risky. Good management, a defined plan of action, ongoing budget monitoring and defined project involvement for functional departments are all required. Costs are most often dropped and slipped due to a lack of capacity to handle operations of this complexity. Assuring that a firm has a clear strategic plan and is aware of the avoiding the most frequent errors from the start will go a long way toward lowering the perils (Wagle, 1998).

The study done by Wagle, (1998) identified five steps process for build a sound enterprise resource planning system. The process consists of five steps as follows,

1. Make a basic model for annual cost-cutting gains that could be achieved without the ERP scheme in operation.
2. Make an ERP argument for the annual gains that might be realized with ERP. This can provide both ERP-dependent and non-ERP-dependent savings.

3. Calculate the net present value (NPV) of the remaining cash flow by subtracting the On a year-over-year basis.
4. When phase 3 generates a positive NPV, a sensitivity analysis will be carried out to guarantee that overruns and slides in costs survive.
5. To allow individual units to budget for them, all ERP framework expenditure on implementation should be reimbursed. Ensure that the delivery of the promised budget is responsible to each unit.

a study done by Wagle, (1998) identified the two main weak points which are the reason for ERP failure.

1. Lack of explicit responsibilities for payments and help with the administration of implementation costs by core businesses
2. Managers accountable for ensuring a project's satisfactory execution absence direct responsibility to the business units.

2.12.1 Lack of defined business unit accountability.

Senior executives sometimes misjudge how much needs be improved in core corporate procedures before an Enterprise Resource Plan system can be adopted successfully. Business divisions lack clear responsibilities for ensuring a successful Enterprise Resource Plan deployment, putting all corporations at risk. This is a problem since the chief executive officer is unlikely to have the power to compel significant changes to business processes. Instead, the application should be overseen by a business unit leader. As per the research done by Wagle, (1998), Companies face the following risks if business divisions lack defined responsibilities for ensuring a successful Enterprise Resource Plan implementation:

- They run the risk of making poor project prioritization choices.
- They may not be able to achieve the savings targets outlined in the business case.
- Their business units cannot be motivated to rethink processes in the way that is required and get the most out of ERP.
- If they don't have explicit contingency plans, they immediately fall behind.

2.12.2 Lack of clarity about who is responsible for what in the business divisions.

As per the research done by Wagle, (1998), The absence of responsibilities of project managers to business segments expresses itself through various aspects: Recurrent changes to the operation specification. As a result, companies hazard delaying the planning period and delaying implementation needlessly.

1. Costs spiral out of control

Where cost controls are missing, Enterprise Resource Plan installations will go over budget by 20% or more.

Five stages can assist decrease Enterprise Resource Plan implementation risks, empower business units own the development, and hold development managers answerable to corporate divisions. (Wagle, 1998).

1. Appoint a business unit chief (rather than an IT department head) to lead the implementation to ensure support. Incentives tied to the progress of the project (defined as completing each process on schedule and on budget) should be provided to this individual. He or she should have the support of other business unit leaders and should report directly to them. This person should be in charge of all technical development staff, including external system integrators.

Phase in financing during the implementation by having established milestones for monitoring savings objectives. On projects of this magnitude, specifying these milestones from the outset assists in maintaining tight cost management.

2. Tracking metrics should be included in the implementation strategy so that commercial unit heads can review improvement toward their cost-cutting and staff-reduction goals. Unit budgets should reflect these objectives, as well as any benchmarks used by top management to assess success.

3. Have a secondary plan in place to prevent against reliance on a single person, and make sure everyone is aware of it. If the firm has a retention plan, it should include the Enterprise Resource Plan project leads.
4. Because the deployment has no direct impact on business units' expenditures, make sure it is factored into their project planning.

CHAPTER 3 – RESEARCH METHODOLOGY

3.1 The Method.

There is a lack of academic work and study on Prioritizing Enterprise Resource Planning Systems for Small and Medium scale Businesses and how they differ, and this article has the potential to fill identified needs.

There are about multiple options to do appropriate research in the broad sense of the word, which are quantitative or qualitative. It specifies whether the investigation is quantifiable or not, as well as if it is based on genuine facts or the writer's interpretation of the topic. This thesis will mostly use a qualitative approach and focus on my understanding of the subject, but it will also incorporate components from a qualitative research technique. That was the starting point for this thesis's work the researcher observed that there are numbers of loop points of the existing process of the organizations. And able to get solution from proposed ERP system and the automated process can bring numbers of benefits to the organization.

3.2 Research Methodology

When investigating an Enterprise Resource Plan scheme that is utilized by virtually everyone in some form, it is critical to make the analysis realistic. Measurements and inspections must be consistent from one moment to the next, and the processes being investigated must be fully independent of just about any system.

This research was broken down into many stages.

The first step was to conduct research and understand much more about issue. Reading and talking with people with experience in the subject will provide information that will be beneficial for future research. This research focuses on a four-step method for implementing Enterprise Resource Plan modules in the construction industry. An online questionnaire survey is used to collect expertize knowledge from the experts in the

industry. This presented method will also assist procurement or construction firms in emphasizing Enterprise Resource Plan modules during the initial implementation stages of Enterprise systems that are actively engaged in partial implementation in order to select the most useful Enterprise solutions in upcoming Enterprise Resource Plan implementations. Professionals in the implementation of Enterprise Resource Plan in the construction area standardized and verified the information, which was then tailored to the specific demands of Sri Lanka's small to medium scale construction industry. The conclusions of this article will help construction businesses to acquire a better knowledge of Enterprise Resource Plan implementation in the construction sector and improve Enterprise Resource Plan implementation overall performance.

For the reading component of the research, articles and journals are considered. It will begin with a comprehensive reading list that will cover subjects such as construction Enterprise Resource Plan frameworks. There are several interpretations on the lack of scholarly literature on construction Enterprise Resource Plan systems. It appears that the issue is still in its infancy, needing further research.

3.3 Questionnaire survey.

An online questionnaire was conducted to inspect the rightness and implementation status of Enterprise resource planning programs in construction firm. Employees of the construction industry were the desired target population.

3.4 Sampling Framework

The respondents are from well-known Sri Lankan construction firms. This study focused on Sri Lanka's grade C1 construction companies, as defined by the Construction Industry Development Authority (CIDA).

3.5 Sampling Technique.

The clustered and convenience (non-Probability) sampling techniques have been practiced for this study. As the first step, clustered the whole construction population in to two groups namely Group one: - Grade C1 construction Companies in Sri Lanka and Group two: - Rest of the Construction companies in Sri Lanka (still not graded under C1 category. Then further clustered the group one in to two sub-group namely, Group three: - Grade C1 construction companies who already have Enterprise Resource Plan system and Group four: - Grade C1 construction companies who already have not Enterprise Resource Plan system. At finally freely address to the population in the group four, volunteer to take party in the study according to their willingness and preferences.

The grade C1 contractors in Sri Lanka are sixty-three. Only thirteen grade C1 construction businesses have effectively deployed ERP systems. The researcher addressed the whole population (Grade C1 contractors with enterprise resource plan systems), and ten of them agreed to take part in the study, accounting for 77% of the total population.

3.6 Respondent Profile

Here describe the demographic characteristics of the respondents. As can be seen, 60 percent of the respondents were both company founders and owners. The majority of responders were between the ages of 40 and 45 Respondents' educational levels show that 60% have state university degrees and 40% only have advanced level and diploma credentials. When it comes to the experience of the entrepreneurs, around 60% have more than 10 years of experience and 30% have more than 5 years of experience. (Appendices 7.2)

CHAPTER 4 – RESEARCH FINDINGS

4.1 The Case Study

Finite Lanka (Pvt) Ltd is a well-established construction firm in the country and provides high-quality products and services for construction. Over 20 years of experience, Finite Lanka has expanded their scope to fields such as road and highway construction, water supply and irrigation and construction. Overtime has strengthened their experience and skills, as it is considered one of the core competencies. They collaborated with international construction companies such as Taisei Cooperation and Kumagai Gumi Company Limited. The Construction Industry Development Authority (CIDA) classified Finite Lanka (Pvt) Ltd under the C1 grade and Finite Lanka (Pvt) Ltd won ISO 9001:2015 specifies requirements for a quality management certificate for their excellence capability to consistently provide products and services that meet customer and applicable legislative and regulatory requirements. Currently the organization is following manual paper based system for record received material (Goods Received Note), issuing material to work shop (Issue Note) and construction site (Transfer Note) and update bin card for each transaction by manually. Further there are Vehicle fleet, Row Materials, Equipment, asphalt Plant and Human resources at main yard and all transaction related to above mentioned areas are handling by manually. The researcher identified the focus group of this organization as Chief Mechanical Engineer, Manager - warehouse and Operation, Assistant Manager - warehouse and Operation, Manager - Asphalt Plant and Operation, Manager – Main Work shop, Assistant Manager – Main Work shop, Store keeper, Accounts Executive, other operational Staffs. With this study the researcher observed that there are numbers of loop points of the existing process of the organizations. And was able to get solutions from proposed ERP system and the automated process can bring numbers benefits toward the organization.

4.2 Methodology

In general, qualitative analysis methodologies are used in ERP implementation, which rely on field study, surveys, case studies, and other approaches. The qualitative approach offers useful insights and a thorough consideration of the phenomena under analysis. Data collection, on the other hand, takes time and is thus expensive than qualitative processes. However, it is highly recommended for researching patterns that encompass a wide variety of activities in complicated sectors.

To study ERP adoption in Sri Lanka's small to medium-sized construction industry, this study proposes a case study approach focused on online questionnaire methodology. The case study approach has been shown to be an effective technique for analyzing ERP implementation issues (Yang et al., 2007). It is clear that applying ERP modules in a sequential order has a higher chance of success than a full-fledged solution (Hallikainen et al., 2009).

Many of the major construction companies in Sri Lanka are in the process of obtaining Enterprise Resource Plan systems to improve their operations. An online survey is a collection of data from a target audience defined by the respondents' invitation and completion of the questionnaire through the Internet. It is one of the most commonly used survey methods. In comparison to previous survey methods such as paper-and-pencil methods and personal interviews, the online survey has proven a speedier way of gathering data from respondents. The researcher used online surveys due to that numerous benefits will be delivered. Online surveys have such a high response rate due to their low cost and general suitability. Respondents will answer questions on their own time and with some tractability in terms of finishing point. The researcher may easily create the layout, questions, and answer options. It is simpler for responders to open up because they are not disclosing their replies to another individual. In certain situations, interviewers have the power to persuade responses.

This study suggests a decision module that is created in four phases (Figure 5):

- First, identify commonly used Enterprise Resource Planning modules in the construction industry and have experts validate them.

- Second, recognize benefit evaluation standards and have experts confirm them. The same ERP experts validate six benefit evaluation criteria for ERP modules: 1 – cost decline; 2 – increased efficiency; 3 – improved decision making; 4 – improved information quality; 5 – Enhanced Consumer Fulfilment; 6 – improved organizational flexibility.
- Third, Using the importance index, evaluate the Enterprise resource planning modules against each assistance parameters.
- Fourth step, Determine the Enterprise Resource Plan Modules' overall ranking.

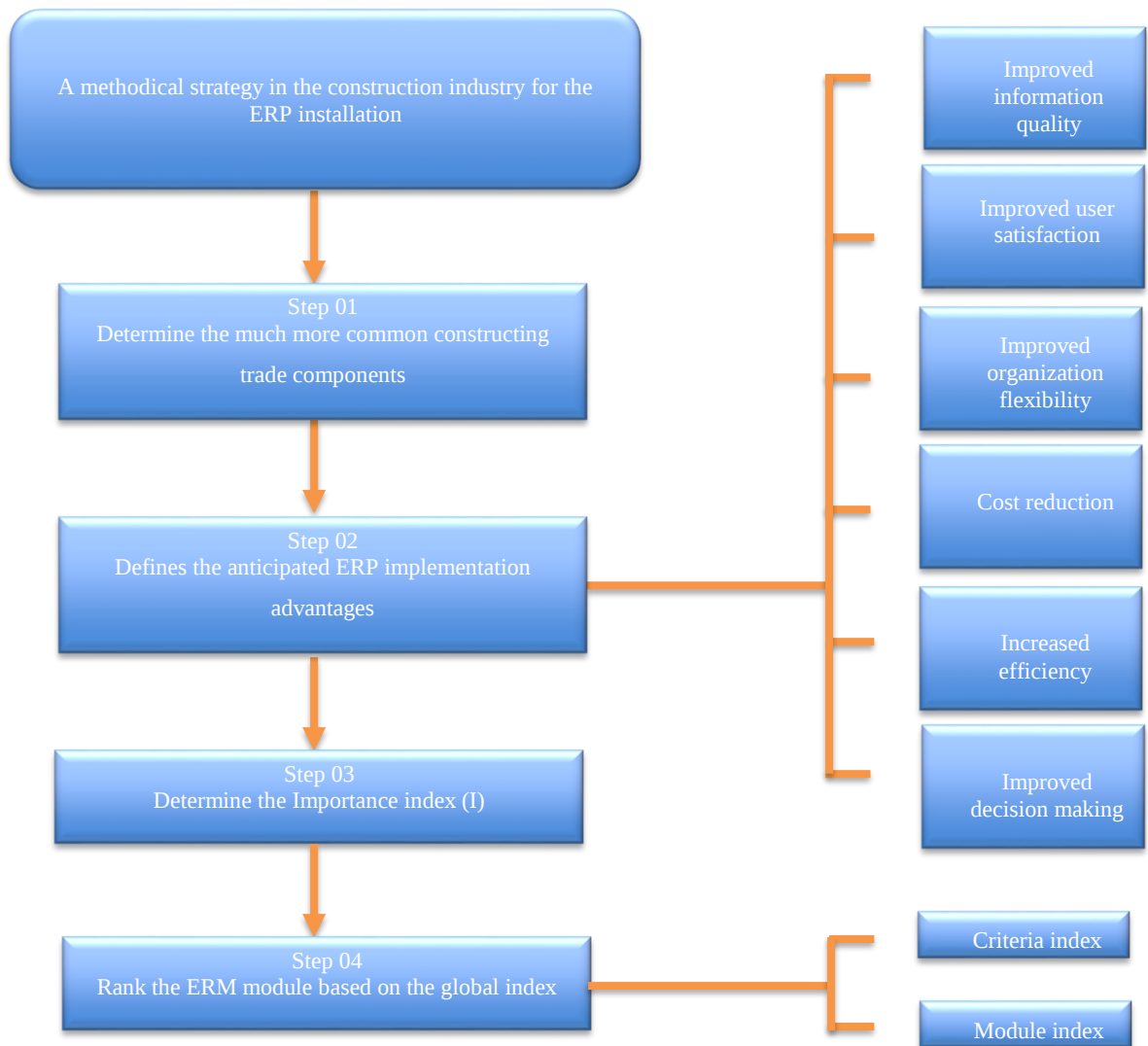


Figure 5: Research Methodology (Shi & Halpin, 2003)

4.2.1 Define common Enterprise Resource Plan modules in the construction projects.

The investigation began with a collection of twelve Enterprise resource planning modules suggested by BooYoung Chung & Skibniewski, (2007) as possible Enterprise resource planning modules for construction firms, namely change management, project data management, Project contract management, Project collaboration, resources management, subcontract management, Project costing, Project billing, inventory control, purchasing, human resources and Time & Labor. During the interviews, the researcher reviewed the previous modules. The comprehensive list of modules was created using the experience of the ERP managers who were interviewed. The ERP modules were reformed into thirteen modules by the researcher, as followings.

1. Sales and Marketing,
2. Human Resources
3. Tendering/Bid Management
4. Resource Management
5. Data/Document Management
6. Collaboration
7. Contract Change Management
8. Project Management and Budgeting
9. Sub-Contractor Management
10. Time, Expenses and Invoicing
11. Project Finance and Invoicing
12. Procurement
13. Inventory Control and logistics

4.2.2 Weights for Benefit Sub-Criteria

The respondents' scoring inputs are used to rank Enterprise resource planning modules. On a scale of 1 to 9, each responder will rate the importance of each benefit category (highest score). An importance index has been used to analyze the collected data. The importance index (I) was as follows. where If all of the respondents (ten) scored the maximum potential

weight, the highest possible count is ninety (nine). Several researchers use Eqn (1) to present the overall average of respondents' evaluations as a percentage (Holt, 2013).

Eqn (1)

$$I = \sum_{i=1}^9 \frac{a_i x_i}{90}$$

Where

- I- Criteria Index
- II- a_i – constant expressing the weight of the i^{th} response, where $a_i = 0, 1, 2, 3, \dots, 9$ for $i = 0, 1, 2, 3, \dots, 9$ respectively
- III- X_i – frequency of i^{th} response given as a percentage of a total responses for each Enterprise Resource Plan module
- IV- i – response category index where $i = 0, 1, 2, 3, \dots, 9$.

4.2.3 Enterprise Resource Plan Modules evaluation.

For each advantage, the poll requests the order of the thirteen components. The thirteen modules are calculated as well as the benefits for each benefit category. A higher rating implies that the module is more useful than others.

4.2.4 Enterprise Resource Plan Modules overall ranking.

As illustrated in Eqn (2), The Enterprise Resource Planning module's total ranking will be decided. This global index is a composite index that combines the importance indices of Enterprise Resource Plan modules and selection criteria into a single index. The thirteen Enterprise Resource Plan modules can be ranked using many criteria.

Eqn (2)

$$Global\ Index = \sum_{i=1}^6 (Module\ Index * Criteria\ Index)$$

Table 2:- The global index of the modules

Module Classification	Global index
Inventory Control and logistics	3.995308642
Procurement	3.859029982
Project Finance and Accounting	3.789488536
Project Management and Budgeting	3.694991182
Time, Expenses and Invoicing	3.578589065
Human Resources	3.472010582
Resource Management	3.462363316
Contract Change Management	3.443350970
Sub-Contractor Management	3.420740741
Collaboration	3.227936508
Data/Document Management	3.046490300
Tendering/Bid Management	3.042645503
Sales and Marketing,	2.810740741

The similar studies were done by numbers of researchers and they investigated what are the most appropriate Enterprise resource plan modules truly fit with the industrial requirements. The researcher uses one of the researches as the benchmark in order to compare the results generated by this study.

One of the study done by Hadidi et al. (2017), all-inclusive list of thirteen Enterprise resource plan modules ranked in Saudi construction industry. The key findings of this study include 13 modules; inventory control, logistics, procurement, project finance, and accounting were the top modules.

The investigator further investigates the reasons behind that why the same results was generated by both study despite considerable variances between two regions that research

done. According to the details found by referring literature review, not only by organizations in considered region but also the organizations in rest of the regions also preferred to the same modules in high rank. one of the research done by Wang & Wang, (2010) investigated that importance of the function of inventory control and logistics to construction organization. According to the study “Logistics management has been widely used in international construction businesses, but its growth in China has been rather slow. It is required and beneficial to concentrate more attention to the use of logistics management in the construction of major projects”.

According to the research findings most of the construction companies in Saudi Arabia as well as Sri Lanka the most preferred Enterprise resources plan module in construction industry is inventory control logistics module.

The ultimate goal of the construction company is profit maximization like as the other firms in any industry. During the process of profit maximization, they make sense of protection of enterprise material as well as industry development. The profit of construction companies is mostly generated from construction projects, Construction cost constraints thereby offer the profit base for the operation. The material costs are usually incorporated in the supply chain network. That means future financial performance on how efficiently materials are handled and capital expenditure on building projects in order to maximize supply cost management. To meet the minimum possible costs to consumers, in other words a suitable balance between performance depends and cost benefit (Wang & Wang, 2010).

The procurement module is ranked in second place by this study as well as the study done by Hadidi et al. (2017),. Construction materials are the key elements in company operations and the creation of a solid, sustainable supply chain management system in companies is the basis for lowering cost of procurement and boost the economic effectiveness. The costs of construction include a considerable proportion of the overall cost, and a significant proportion of the cost of raw materials is bought. in building projects. Therefore, if procurement costs can be reduced the business will improve its profitability (Wang & Wang, 2010).

The ranked third place is going to the project finance and accounting module. The project finance and accounting module also an important module while considering the rest of the modules listed by the researcher. Accounting and financial management are critical components of every profitable construction project. Construction project funding help to the organization to fill the gap between making recurring expenditure and collecting payment from the project's owners. The contractor would incur at least two months of expenditures before receiving the first payment from the developer at the commencement of construction contract, with successive progress payments paid by the developer on monthly intervals after that. The construction company must cover the cost of the delay in obtaining payment. as many contractors cannot afford to wait for payment for an extended period of time in order to pay their suppliers and workers, they are typically expected to be paid sooner rather than later.

By considering above clarifications by the various of studies done in global context, validates that inventory control and logistics, procurement, and project finance and accounting modules are most prominence to process of implementing new construction enterprise resource plan to the construction organization.

The main objective of this paper," identify the what is the suitable ERP module for small and medium scale construction business organization in Sri Lanka" has been justified. Then have to be proofed other sub objective by means of the acquired knowledge with the literature review.

Then noticed that, there is a delay in the process of the decision taking with the traditional Business Intelligence (BI) settings. They have become more and more mismatched with the pressures of current business environments. Further they have to analysis of historical information, and limited in their ability to fill the gap between information and action. With these difficulties of the existing business intelligence tools, they have step forward to the real-time business intelligence (RTBI) systems. Even though this overcome potential characteristics of traditional decision-making system and offer numbers of value adding paybacks to the organization.

The business entity may think of new ways to perform their decision making real-time and to align with the changes in the business environment. These issues lead to the organizations to using information systems for improvement of business performance and more effectiveness of the process of decision making. Enterprise resource planning (ERP) is one of the systems which makes integrated process by using shared database and real time information. While generating numerous benefits to the organization, Enterprise Resource Plan unable to act as a Business Intelligence Systems to analyses data and to support decision making process. The business intelligence (BI) makes easy to the organization in order to integration historical data and improving decision making process. All of the users of Enterprise Resource Plan are able to access to huge capacity of data and analyses. This ability leads to make business decisions. Enterprise Resource Plan might be known as a basic tool for Business Intelligence specially to collect and integrate data into a central data base.

The organization able to achieve desired benefits of Enterprise resource plan while it will be ready for Business intelligence implementation. Organization that have implemented Enterprise resource plan able to easily take part with Business Intelligence system. The organization that have both Enterprise resource plan and business intelligence can get advantages embedded with real-time monitoring aspect.

Also noted that cloud Cloud-based Enterprise Resource Plan also can play big role with real-time monitoring aspect. Cloud-based ERP is a premium service enterprise resource planning solution supplied by cloud service providers to organizations. ERP software features are accessible from any Internet-connected device via a remote cloud server. The numerous of advantages able to be obtained by using Cloud based enterprise resource planning system as declared in literature review.

CHAPTER 5 – CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

The research provided here is a challenge to address the adoption of Enterprise Resource Plan in Sri Lanka's small to medium construction sector. The state of technology in the construction sector in Sri Lanka does not reach international standards. The study's findings will help Sri Lankan small and medium sized construction businesses acquire and implement Enterprise Resource Plan systems. This is also a good approach for rating Enterprise Resource Plan modules for construction companies all around the world. Companies who want to use the method in their own firm might do so and obtain different rankings depending on their requirements. The construction industry's Enterprise Resource Plan deployment has sparked a lot of study, given the fact that such implementations are loaded with risks of failure. As a result, construction companies welcome new approaches to better manage Enterprise Resource Plan implementations since they help them reduce the risk of failure and optimize the advantages of implementation. This study's methodology aids small and medium-sized construction enterprises in Sri Lanka in effectively implementing Enterprise Resource Plan projects.

The process under this study includes the following steps:

Step 01 - outlines the most common building Enterprise Resource Plan modules that may be easily modified to match the unique requirements of businesses all across the world.

Step 02 - The projected benefits of implementing Enterprise Resource Plan are described.

Some of the advantages are economic gains, enhanced efficiency, better decision-making, improved knowledge reliability, better user happiness and stronger organizational versatility. The aforementioned advantages were gathered based on accessible Enterprise Resource Plan implementation material from all over the world.

Step 03 - based on the replies of the companies under investigation, determined the significance index (I) for the six benefits. This index may vary from one firm to another, providing for some flexibility in the proposed methodology.

Step 04 - The global index, which combines the criteria index and module index, is used to rank ERP modules.

The information was gathered from ten numbers of Sri Lanka's top construction companies. Inventory control and logistics, procurement, and project finance and accounting were the top three modules out of thirteen. The research findings will help building businesses to prioritize the acquisition of different ERP modules which can easily be tailored to their specific requirements.

5.2 Recommendations

In this study, Enterprise Resource Plan advantages are utilized as a ultimate measure of Enterprise Resource Plan success, The more comprehensive a company resource plan is, the more value it gets from the enterprise resource plan. The major reason for construction firms to use Enterprise Resource Plan systems is to enhance efficiency and decrease waste. These benefits can only be realized via the efficient implementation and acceptance of Enterprise Resource Plan. So, how can we achieve the success that comes with these massive Enterprise Resource Plan benefits?

What drives small business owners to implement an Enterprise Resource Plan system? One option is for the Enterprise Resource Plan system to be regarded as useful, therefore decision-makers should consider variables that impact usefulness in order to increase Enterprise Resource Plan success. In this study, the top three modules were shown to be inventory control and logistics, procurement, and project finance and accounting. As a result of this discovery, the following recommendations are made to increase the use of the Enterprise Resource Plan system:

1. The mainstream of contractor companies has some "know-how" about Enterprise Resource Plan systems and assume that implementing Enterprise Resource Plan systems would help their businesses by allowing for improved coordination of operating environments, increased automation, and greater consistency in processes

and information access. However, it has been discovered that Enterprise Resource Plan system deployment necessitates a significant amount of financial, human, and technological resources, making it difficult for small contracting companies to participate in such a mega-system.

2. According to the literature review, the complexity of Enterprise Resource Plan and the shortage of adequate skill sets in project workers are stumbling blocks to Enterprise Resource Plan adoption in the construction industry. Enterprise Resource Plan tech providers must collaborate with construction industry experts to create more personalized applications for contracting companies.
3. Implementing an Enterprise Resource Plan system is costly for small firms owing to the necessity for hardware and software licenses. As a result, cloud-based Enterprise Resource Plan systems are becoming more popular, especially as manufacturers begin to offer systems as Software-as-a-Service, allowing businesses to avoid investing in pricey hardware.

5.3 Future Research

Despite the fact that this study has provided members of Small and Medium Scale Construction Organizations with practical and theoretical benefits, there is still a lot of opportunity for future improvements in this field.

The following are some of the possible areas that might be studied more in the future:

- This research's methodology should be examined thoroughly. Additional case studies and scientific studies on the various types of modules should be performed.
- Another topic of interest that may be researched is the development of Enterprise Resource Plan implementation standards. These recommendations may be useful in determining the bare minimum for an Enterprise Resource Plan implementation effort. The integration of current standards would improve the Enterprise Resource

Plan community's ability to successfully address the demands and expectations of client categories.

- A study on how to successfully educate and acquaint the community of Small to Medium Sized Construction Organizations with the idea of Enterprise Resource Plan might be undertaken. Representatives of the Small to Medium-Sized Construction Organization public are infrequently aware of Enterprise Resource Plan systems and their potential in their current state. They are oblivious to the various benefits that may be obtained by using an Enterprise Resource Plan system. It is necessary for managers of small to medium-sized building enterprises to be made aware of and plan to use the advantage of enterprise resource plan systems throughout their businesses.

According to the literature analysis, there are several Enterprise resource plan advantages and real-time monitoring criteria, and it is not impossible to investigate all of them in a single study. As a result, some of them are considered in this study. The following topics will be taken into consideration in the future studies.

- Studying the effect of Enterprise Recourse plan benefits on the Business Intelligence system.
- Studying the integration of Enterprise Recourse plan and Business Intelligence system.
- The impact of integrating business intelligence system with Enterprise Recourse plan on decision making process of the small and medium scale construction company.
- The impact of Business Intelligence system to real-time monitoring system of the construction company.

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APPENDICES

Appendix – A Online survey questioner

Online Questionnaire

This online survey is conducted in order to collect your expert insights on the Enterprise Resource Planning (ERP) of organizations you have worked for in the construction sector. The data is collected in partial fulfilment of an MBA in Supply Chain Management at the University of Moratuwa. By participating in the survey, you are consenting to the use of data for research and publication purposes.

mknuwan@gmail.com [Switch account](#) 

*** Required**

Email *

Your email

Mention Age *

☐ 31 - 35 years old

☐ 36 - 40 years old

☐ 46 - 50 years old

☐ 51 - 55 years old

☐ Above 55 years old

Describe Level of Education *

- ☐ State university graduate
- ☐ Advanced Level and diploma
- ☐ Ordinary Level

Describe the industry you are working for

- ☐ IT
- ☐ Consulting
- ☐ Construction
- ☐ Other: _____

What is the current position ?

Your answer _____

How many years have you been working in the industry you selected in question 1?

Your answer

What is the approximate annual revenue of your company?

Choose

Does your company use an Enterprise Resource Planning (ERP) system?

- ☐ Yes
- ☐ No
- ☐ Presently installing one

Have you worked for or been involved in an ERP implementation Project?

- ☐ Yes
- ☐ No

What are the most important business processes in your ERP according to your perception? List the most important modules first.

Your answer

Please assign a score indicating the value for following business processes that you are willing to implement by introducing a Construction Enterprise Resource planning system into the business.(1 is lowest and 9 is highest) *

	1	2	3	4	5	6	7	8	9
Cost Reduction	☐	☐	☐	☐	☐	☐	☐	☐	☐
Increased efficiency	☐	☐	☐	☐	☐	☐	☐	☐	☐
Improved decision making	☐	☐	☐	☐	☐	☐	☐	☐	☐
Improved information quality	☐	☐	☐	☐	☐	☐	☐	☐	☐
Improved user's satisfaction	☐	☐	☐	☐	☐	☐	☐	☐	☐
Improved organization flexibility	☐	☐	☐	☐	☐	☐	☐	☐	☐

How did ERP help these processes? please explain

Your answer

What problems do you have in the ERP system with respect to these processes?

Your answer

What problems do you have in the ERP system with respect to these processes?

Your answer

What is the most critical ERP modules in the Construction industry? Please assign a score indicating the value from the following thirteen modules according to your perception. (1 is the lowest and 9 is the highest) *

	1	2	3	4	5	6	7	8	9
Sales and Marketing	☐	☐	☐	☐	☐	☐	☐	☐	☐
Human Resources	☐	☐	☐	☐	☐	☐	☐	☐	☐
Tendering/Bid Management	☐	☐	☐	☐	☐	☐	☐	☐	☐
Resource Management	☐	☐	☐	☐	☐	☐	☐	☐	☐
Data/Document Management	☐	☐	☐	☐	☐	☐	☐	☐	☐
Collaboration	☐	☐	☐	☐	☐	☐	☐	☐	☐
Contract Change Management	☐	☐	☐	☐	☐	☐	☐	☐	☐
Project Management and Budgeting	☐	☐	☐	☐	☐	☐	☐	☐	☐
Sub-Contractor Management	☐	☐	☐	☐	☐	☐	☐	☐	☐
Time, Expenses and Invoicing	☐	☐	☐	☐	☐	☐	☐	☐	☐
Project Finance and Invoicing	☐	☐	☐	☐	☐	☐	☐	☐	☐
Procurement	☐	☐	☐	☐	☐	☐	☐	☐	☐

What are the most important current challenges/problems faced presently with the ERP

system?.....
.....
.....
.....
.....

Your answer

Do you get a competitive advantage over your competitors after the implementation of the ERP system?

Your answer

If yes, how? Please describe.

Your answer

Appendix – B The profile characteristics of respondents

Age of the Respondent (in Years)	Frequency	Percentage (%)
31-35	1	10
36-40	2	20
41-45	4	40
46-50	1	10
51-55	1	10
Above 55	1	10
Levels of Education		
State University Graduate	6	60
Advanced level and Diploma	4	40
Previous business experience		
More than 10 years	6	60
5 - 10 years	3	30
2 - 5 years	1	10
Current position of the respondent		
Founder and owner	6	60
Owner	2	20
Manager	2	20

Appendix – C Criteria Index

	Rank Count									Criteria Index
	1	2	3	4	5	6	7	8	9	
Cost Reduction				1		3	4	1	1	74.44%
Increased efficiency			2				4	2	2	75.56%
Improved decision making						2	2	2	4	86.67%
Improved information quality		2			2	1	1	1	3	68.89%
Improved user's satisfaction		2	1	2	1	1	1	1	1	55.56%
Improved organization flexibility			1	2		3	1	2	1	67.78%
Sum										4.29

Appendix – D Index for benefits of Increased Efficiency and cost reduction.

Category of the Module	Cost Reduction										Increased Efficiency									
	1	2	3	4	5	6	7	8	9	Index	1	2	3	4	5	6	7	8	9	Index
Sales and Marketing,	0	3	0	0	2	0	3	1	1	60.00%	0	0	2	2	2	0	3	0	1	85.71%
Human Resources	0	0	0	2	0	0	3	2	3	80.00%	0	0	1	1	1	2	2	0	3	103.17%
Tendering/Bid Management	0	0	0	0	2	4	0	2	2	75.56%	0	1	2	2	0	1	1	1	2	87.30%
Resource Management	0	0	0	2	2	2	1	1	2	70.00%	0	0	0	1	1	1	2	3	2	112.70%
Data/Document Management	0	0	0	3	0	3	2	1	1	67.78%	0	2	1	1	0	0	4	0	2	90.48%
Collaboration	0	0	4	0	0	2	2	1	1	61.11%	0	0	0	1	2	2	1	2	2	106.35%
Contract Change Management	0	0	0	2	2	1	1	2	2	72.22%	0	0	0	0	2	2	3	2	1	107.94%
Project Management and Budgeting	0	0	2	2	0	0	1	2	3	71.11%	0	0	0	0	0	2	2	4	2	120.63%
Sub-Contractor Management	0	0	0	2	1	3	2	0	2	70.00%	0	0	2	1	1	1	2	2	1	95.24%
Time, Expenses and Invoicing	0	0	0	2	3	2	0	1	2	67.78%	0	0	0	1	1	1	3	1	3	112.70%
Project Finance and Accounting	0	0	0	1	1	2	2	1	3	77.78%	1	0	0	0	0	1	2	4	2	112.70%
Procurement	0	0	0	0	2	1	1	2	4	83.33%	0	0	0	0	1	2	2	2	3	117.46%
Inventory Control and logistics	0	0	0	0	0	1	2	3	4	88.89%	0	0	0	0	0	2	2	2	4	123.81%

Appendix – E Index for Improved Decision Making and Improved Information Quality

Category of the Module	Improved Decision Making										Improved Information Quality									
	1	2	3	4	5	6	7	8	9	Index	1	2	3	4	5	6	7	8	9	Index
Sales and Marketing,	2	1	1	0	2	1	1	1	1	52.22%	0	0	2	0	3	1	3	0	1	63.33%
Human Resources	0	0	0	2	1	1	2	2	2	74.44%	0	0	0	0	2	0	3	3	2	81.11%
Tendering/Bid Management	0	2	1	1	0	0	2	2	2	65.56%	0	0	0	0	3	2	2	1	2	74.44%
Resource Management	0	0	0	0	2	0	4	2	2	80.00%	0	0	0	1	4	0	2	1	2	71.11%
Data/Document Management	0	0	1	1	2	3	2	0	1	64.44%	0	0	0	2	2	2	2	1	1	67.78%
Collaboration	2	0	1	1	2	0	1	2	1	56.67%	2	1	1	0	1	0	2	1	2	57.78%
Contract Change Management	0	0	0	0	2	3	2	2	1	74.44%	0	0	0	2	0	2	2	1	3	76.67%
Project Management and Budgeting	0	0	0	0	2	1	4	1	2	77.78%	0	0	0	0	0	2	4	2	2	82.22%
Sub-Contractor Management	0	0	0	1	2	2	2	1	2	73.33%	0	0	0	0	2	2	2	2	2	77.78%
Time, Expenses and Invoicing	0	0	2	0	0	2	3	1	2	72.22%	0	0	2	0	1	1	2	2	2	72.22%
Project Finance and Accounting	0	0	0	0	2	2	2	2	2	77.78%	0	0	0	0	0	1	3	3	3	86.67%
Procurement	0	0	0	0	0	2	2	3	3	85.56%	0	0	0	0	3	1	2	1	3	77.78%
Inventory Control and logistics	0	0	0	0	0	2	3	2	3	84.44%	0	0	0	0	3	1	2	1	3	77.78%

Appendix – F Index for Improved User Satisfaction and Improved Organizational Flexibility

Category of the Module	Enhanced Consumer Fulfilment										Improved Organizational Flexibility									
	1	2	3	4	5	6	7	8	9	Index	1	2	3	4	5	6	7	8	9	Index
Sales and Marketing,	0	2	0	0	4	2	1	0	1	82.54 %	0	2	1	1	3	0	2	0	1	54.44 %
Human Resources	0	1	1	2	2	0	1	1	2	88.89 %	0	1	2	1	1	2	1	1	1	58.89 %
Tendering/Bid Management	0	2	0	3	2	1	1	0	1	76.19 %	2	2	1	0	2	0	2	0	1	46.67 %
Resource Management	0	1	2	1	3	1	1	0	1	77.78 %	0	0	0	1	2	2	4	0	1	70.00 %
Data/Document Management	0	0	2	1	2	2	1	0	2	90.48 %	0	0	2	2	2	1	2	0	1	58.89 %
Collaboration	0	0	0	0	3	2	2	1	2	106.35 %	0	0	0	0	3	2	3	1	1	72.22 %
Contract Change Management	0	0	0	2	4	2	0	1	1	90.48 %	0	0	2	1	3	0	3	0	1	61.11 %
Project Management and Budgeting	0	0	0	2	2	2	1	2	1	98.41 %	0	0	0	2	2	2	2	0	2	68.89 %
Sub-Contractor Management	0	0	0	0	3	3	2	1	1	101.59 %	0	0	0	2	2	3	2	0	1	65.56 %
Time, Expenses and Invoicing	0	0	0	0	4	2	1	2	1	101.59 %	0	0	0	0	2	1	2	4	1	78.89 %
Project Finance and Accounting	0	0	0	0	4	0	2	3	1	106.35 %	0	0	0	1	2	2	1	3	1	73.33 %
Procurement	0	0	0	2	2	2	1	2	1	98.41 %	0	0	0	0	2	2	2	2	2	77.78 %
Inventory Control and logistics	0	0	0	0	3	3	1	2	1	103.17 %	0	0	0	0	0	3	2	3	2	82.22 %

Appendix – G Global Index

Name of the Criteria	Important Index	Criteria Index	Name of the Modules	Global Index
			Inventory Control and logistics	3.995308642
Cost Reduction	88.888888889%	74.444444444%	66.172839506%	
Increased Efficiency	123.809523810%	75.555555556%	93.544973545%	
Improved Decision Making	84.444444444%	86.666666667%	73.185185185%	
Improved Information Quality	77.777777778%	68.888888889%	53.580246914%	
Improved User Satisfaction	103.174603175%	55.555555556%	57.319223986%	
Improved Organizational Flexibility	82.222222222%	67.777777778%	55.728395062%	
			Sales and Marketing,	2.810740741
Cost Reduction	60.000000000%	74.444444444%	44.666666667%	
Increased Efficiency	85.714285714%	75.555555556%	64.761904762%	
Improved Decision Making	52.222222222%	86.666666667%	45.259259259%	
Improved Information Quality	63.333333333%	68.888888889%	43.629629630%	
Improved User Satisfaction	82.539682540%	55.555555556%	45.855379189%	

Improved Organizational Flexibility	54.4444444444%	67.777777778%	36.901234568%	
			Human Resources	3.472010582
Cost Reduction	80.000000000%	74.444444444%	59.555555556%	
Increased Efficiency	103.174603175%	75.555555556%	77.954144621%	
Improved Decision Making	74.444444444%	86.666666667%	64.518518519%	
Improved Information Quality	81.111111111%	68.888888889%	55.876543210%	
Improved User Satisfaction	88.888888889%	55.555555556%	49.382716049%	
Improved Organizational Flexibility	58.888888889%	67.777777778%	39.913580247%	
			Tendering/Bid Management	3.042645503
Cost Reduction	75.555555556%	74.444444444%	56.246913580%	
Increased Efficiency	87.301587302%	75.555555556%	65.961199295%	
Improved Decision Making	65.555555556%	86.666666667%	56.814814815%	
Improved Information Quality	74.444444444%	68.888888889%	51.283950617%	
Improved User Satisfaction	76.190476190%	55.555555556%	42.328042328%	
Improved Organizational Flexibility	46.666666667%	67.777777778%	31.629629630%	

			Resource Management	3.462363316
Cost Reduction	70.000000000%	74.444444444%	52.111111111%	
Increased Efficiency	112.698412698%	75.555555556%	85.149911817%	
Improved Decision Making	80.000000000%	86.666666667%	69.333333333%	
Improved Information Quality	71.111111111%	68.888888889%	48.987654321%	
Improved User Satisfaction	77.777777778%	55.555555556%	43.209876543%	
Improved Organizational Flexibility	70.000000000%	67.777777778%	47.444444444%	
			Data/Document Management	3.046490300
Cost Reduction	67.777777778%	74.444444444%	50.456790123%	
Increased Efficiency	90.476190476%	75.555555556%	68.359788360%	
Improved Decision Making	64.444444444%	86.666666667%	55.851851852%	
Improved Information Quality	57.777777778%	68.888888889%	39.802469136%	
Improved User Satisfaction	90.476190476%	55.555555556%	50.264550265%	
Improved Organizational Flexibility	58.888888889%	67.777777778%	39.913580247%	
			Collaboration	3.227936508

Cost Reduction	61.111111111%	74.444444444%	45.493827160%	
Increased Efficiency	106.349206349%	75.555555556%	80.352733686%	
Improved Decision Making	56.666666667%	86.666666667%	49.111111111%	
Improved Information Quality	57.777777778%	68.888888889%	39.802469136%	
Improved User Satisfaction	106.349206349%	55.555555556%	59.082892416%	
Improved Organizational Flexibility	72.222222222%	67.777777778%	48.950617284%	
			Contract Change Management	3.443350970
Cost Reduction	72.222222222%	74.444444444%	53.765432099%	
Increased Efficiency	107.936507937%	75.555555556%	81.552028219%	
Improved Decision Making	74.444444444%	86.666666667%	64.518518519%	
Improved Information Quality	76.666666667%	68.888888889%	52.814814815%	
Improved User Satisfaction	90.476190476%	55.555555556%	50.264550265%	
Improved Organizational Flexibility	61.111111111%	67.777777778%	41.419753086%	
			Project Management and Budgeting	3.694991182
Cost Reduction	71.111111111%	74.444444444%	52.938271605%	

Increased Efficiency	120.634920635%	75.555555556%	91.146384480%	
Improved Decision Making	77.777777778%	86.666666667%	67.407407407%	
Improved Information Quality	82.222222222%	68.888888889%	56.641975309%	
Improved User Satisfaction	98.412698413%	55.555555556%	54.673721340%	
Improved Organizational Flexibility	68.888888889%	67.777777778%	46.691358025%	
			Sub-Contractor Management	3.420740741
Cost Reduction	70.000000000%	74.444444444%	52.111111111%	
Increased Efficiency	95.238095238%	75.555555556%	71.957671958%	
Improved Decision Making	73.333333333%	86.666666667%	63.555555556%	
Improved Information Quality	77.777777778%	68.888888889%	53.580246914%	
Improved User Satisfaction	101.587301587%	55.555555556%	56.437389771%	
Improved Organizational Flexibility	65.555555556%	67.777777778%	44.432098765%	
			Time, Expenses and Invoicing	3.578589065
Cost Reduction	67.777777778%	74.444444444%	50.456790123%	
Increased Efficiency	112.698412698%	75.555555556%	85.149911817%	

Improved Decision Making	72.222222222%	86.666666667%	62.592592593%	
Improved Information Quality	72.222222222%	68.888888889%	49.753086420%	
Improved User Satisfaction	101.587301587%	55.555555556%	56.437389771%	
Improved Organizational Flexibility	78.888888889%	67.777777778%	53.469135802%	
			Project Finance and Accounting	3.789488536
Cost Reduction	77.777777778%	74.444444444%	57.901234568%	
Increased Efficiency	112.698412698%	75.555555556%	85.149911817%	
Improved Decision Making	77.777777778%	86.666666667%	67.407407407%	
Improved Information Quality	86.666666667%	68.888888889%	59.703703704%	
Improved User Satisfaction	106.349206349%	55.555555556%	59.082892416%	
Improved Organizational Flexibility	73.333333333%	67.777777778%	49.703703704%	
			Procurement	3.859029982
Cost Reduction	83.333333333%	74.444444444%	62.037037037%	
Increased Efficiency	117.460317460%	75.555555556%	88.747795414%	
Improved Decision Making	85.555555556%	86.666666667%	74.148148148%	

Improved Information Quality	77.777777778%	68.888888889%	53.580246914%	
Improved User Satisfaction	98.412698413%	55.555555556%	54.673721340%	
Improved Organizational Flexibility	77.777777778%	67.777777778%	52.716049383%	