THE MATURITY AND USAGE OF ENTERPRISE RESOURCE PLANNING (ERP) SYSTEMS IN MANUFACTURING ORGANIZATIONS IN SRI LANKA

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ABSTRACT

Enterprise resource planning has been an essential feature in medium to large scale manufacturing organizations in modern era. The world is looking for automated information solutions which involve ERP systems for better effective performance. This includes upgrading or changing the systems with new technologies, aligning systems with business requirements, customized ERP solutions, managerial interest in ERP adaptations or upgrades etc. Only not within organizations only, going in upstream and downstream supply chains having collaborative ERP packages will also give tremendous benefits for its users. As ERP benefits and effective usage becoming a priority for most of the organizations across the world, when it comes to Sri Lanka it is quite unfortunate to see that most of the organizations are still struggling over accurate usage of ERP which leads to negative impact in terms of profit generation and cost reductions.

The main objective of this research is to find out factors affecting efficient usage of ERP and current maturity level of ERP in manufacturing organizations of Sri Lanka. The population of this research is manufacturing organizations of Sri Lanka those in which ERP systems have been already implemented. Data was collected using a sample identified from LMD – a leading business magazine in Sri Lanka where firms were approached through an online questionnaire and several prior interviews with industry experts. Five point Likert scale and exploratory factor analysis followed with multiple regression modeling were used to gather and analyze data in ERP usage Model. A simple ranking method was used to identify the maturity model of ERP systems in leading manufacturing organizations in Sri Lanka.

The research concludes with a statistically proven result that Business Process fit along with knowledge and training on ERP, Analytical capability of ERP for better decision making, Collaborative ERP, Technical Resources and Data flow of the ERP as key factors in determining ERP usage of manufacturing organizations. And majority of these organizations in Sri Lanka fall to stage two in maturity model where organizations are still in exploring stage after the implemented ERP systems.

Keywords – ERP Systems, Information Systems, Maturity, ERP usage, Factor analysis

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1. INTRODUCTION

ERP systems have been increasingly acquiring attention in world for past decades. Today with emerging trends and technologies these information systems have become a main focus in both medium to large scale organizations across the globe. Especially to the manufacturing industry given the fact that they involve more and more vivid supply chain operations without boundaries, ERP systems have become closer than ever. ERP systems are complex software packages that integrate information and business processes within and across functional areas of the business (Nwankpa J. K., 2014). ERP systems have been designed to integrate functions and expected to make organization functions to sail smooth.

In the current business landscape, the organizations are focusing on continuous improvements in economy and efficiency of the organizational activities in order to gain the edge over their competitors. And to achieve that adopting faster and most updated software solution has become the new norm. But the question is do we actually need them? Or do we actually use our resources we have to the full potential? Organizations tend to implement ERP systems after spending huge amount of implementation costs but do not get the real usage over time. There can be seen several significant differences in ERP strategies that organizations use in terms of how they are implemented initially, customized designs, how they are linked to other information systems and what are the features and functions which are critical? In this research the focus will be mainly in two areas, ERP usage and ERP Maturity.

1.1. Objective of the Study

ERP systems have their own benefits and drawbacks. When it comes to global context, companies with efficient ERP systems have been able to gain competitive advantage over the other companies with similar performances.

The increasing dependency of manufacturing organizations with ERP systems has been the focus of this research. To understand the gap between ERP expectations and what ERP offers to its users this research will try to identify the factors that affect to

ERP usage. Also the research will focus on current level of ERP maturity in Sri Lankan manufacturing context. Studies by Steve Baldwin, a senior ERP consultant, discovered that many survived companies that had implemented ERP systems only get 50% to 75% full benefits of the functions in ERP systems. (Caldwell & Stein, 1998).Since relatively less research has been done on after implementation issues on ERP even in the global context, this research will provide a foundation on which other researches can carry out their studies to the next level.

The main objectives of the study can be identified as below;

- Identify factors affecting ERP usage in Sri Lankan manufacturing organizations.
- Identify the maturity level of those top major players in Sri Lankan manufacturing context against global context.
- Identify most common ERP systems & the current state of ERP in manufacturing context of Sri Lanka

Only a handful of researches have been done focusing on the relationship in ERP usage and ERP maturity in Sri Lanka which provided an insight to this research paper. The reason for selecting manufacturing organizations was that the fact that ERP formulation was linked to material requirement planning in manufacturing organizations, so that the origination of ERP happens to be from manufacturing organizations. And today the manufacturing industry is only second for banking industry in terms of purchasing ERP solutions from its vendors.

Though the manufactures continuously invest on ERP systems and modern information systems, the problem identified in the research was there was lack in effective usage of ERP. So to overcome this problem the research will provide some factors which can be used by the organizations to uplift their usage of ERP. Also the research will focus on identifying the key ERP vendors in Sri Lankan manufacturing ERP market. Meanwhile this research article will try to build up an ERP maturity model which provides an insight about manufacturing industry of Sri Lanka.

1.2. Significance of the research

ERP has become a necessity to large scale organizations. Even in small and medium scale environments ERP systems have become popular. Most of the organizations install these software packages without proper knowledge on the usability or about the features and functions they have. Especially when it comes to countries like Sri Lanka other than multinationals rest of the organizations still struggle in implementing and maintaining these ERP solutions due to lack of knowledge and huge costs related to them. Also, most of the organizations and their ERP users tend to resist so much to changes on current practices which will drag down the overall performances of the organization resulting competitive advantage to their competitors.

It is needed to get updated time to time for a better performance in this competitive structure in manufacturing field. Also several studies have suggested as a main reason for ERP failures in countries like Sri Lanka, the fact that organizations tend to get unnecessary packages from ERP service providers and miss the most necessary segments. The ERP solutions that the organizations use should fit the operations of the organization and that should be helpful to its employees without being burden.

ERP users should also take the full use of the implemented ERP systems and knowledge regarding handling the ERP solutions should be given through a well-organized process. Organizations in the world now moving forward with better technology, better concepts in order to achieve better performances and to reduce costs and lead times in supply chains. As a country Sri Lanka also should practice those good practices to maximize profits as well as to enter to the global market.

1.3. Scope of the research

As the topic suggests, the scope of this research was at the limits to find out the relationship of ERP usage and ERP maturity level in manufacturing organizations of Sri Lanka. When it comes to the literature in this particular research area, several researches can be found in the global context and in the regional context. But it's

doubtful whether theses global findings are applicable to Sri Lankan context as the factors affecting the findings vary in a large scale as the countries vary.

As mentioned above, topic was narrowed down to manufacturing organizations considering the origination of ERP systems and in order to be specific and focused on research findings. Also this helped to increase the convenience of data gathering. The topic was not further narrowed down because it would have been tougher to gather data in such situations. When it comes to supply chain management manufacturing has been the significant component which contributes the largest to the value chain has also been a major reason to choose manufacturing organizations.

Since there were no records or lists could be found when it comes to manufacturing companies, the topic had to be further narrowed down to identify the sample. Therefore as one of the leading business magazine of Sri Lanka, LMD data was used for the sample. Best performing fifty companies from LMD 2018 magazine were selected considering that these companies should have been using an ERP system with a greater likelihood.

As for the above reasons, the basic scope of this research was the manufacturing companies in Sri Lanka which have implemented ERP systems. Factors affecting ERP usage and the level of maturity in those implemented ERP systems will be the ultimate outcome of this research

2. LITERATURE REVIEW

2.1. Introduction to the study

Oxford defines ERP - Enterprise resource planning as an integrated computer system that manages all the information and resources involved in a company's operations. ERP was developed basically from material requirement planning (MRP I) and manufacturing resource planning (MRPII). (Wilson, 2016) Back in 1964 MRP was initially introduced by Joseph Orlickyin through Toyota Manufacturing program and later in 1983 developed by Oliver Wight as manufacturing resource planning. In 1990 an extended version of MRP I and MRP II along with computer-integrated manufacturing was introduced by Gartner Group. (Sheilds, 2005).Today over the years these ERP systems have grown as complex software package that enables all critical functions in an enterprise not only in manufacturing segment but also in all the other categories such as finance, human resource, supply chain and marketing. Not only these software packages integrate different components along in an organization they also are designed to work together for better performance of the organization generating more profits. Because of this so called advantage almost all the companies especially in manufacturing category tend to move rapidly towards ERP system implementations in past decade. Now it has become a norm to have an ERP system with huge implementation costs in order to have organization success.

The main focus of ERP system is to integrate operations throughout an organization. But given the fact that the implementations of these ERP software come as packages with infrastructural and multidimensional nature, it can be difficult for organizations to determine which aspects of the ERP will influence the organization for better performance and which aspects are not needed to implemented. So identifying the appropriate modules of ERP and the cost factor attached with the implementation of specific module and prioritizing them according to the requirement was a must. On the other hand, ERP benefits are classified basically into five major categories: operational, managerial, strategic, IT infrastructural and organizational. (Shang & Seddon, 2000) In this study automation benefits and streamlining information process was categorized as operational. Easiness to plan, production and to manage resources

including manpower in an efficient and much effective manner were classified as managerial benefits. In the strategic perspective monitor and control the financial performance of products, customers, business lines or geographic areas were highlighted. Controlling and monitoring, financial performance of products, customers, business lines or geographic areas and facilitating business learning were added to organizational benefits sector.

ERP was designed in a such a way that it will make organizations tasks easier especially those are meant to be helpful in organization's operation procedures which leads to tremendous benefits from these systems. A prior studycategorized ERP benefits as, 1) improving information flow across sub-units, standardizing and integrating to facilitate communication. 2) Enabling the centralization of administrative activities such as accounts payable and payroll. 3) Reducing IT maintenance costs and increasing the ability to deploy new IS functionality. 4) Moving an organization away from inefficient business processes and towards accepted best practices. (Gattiker & Goodhue, 2000) According to these findings simply ERP benefits related to organizational dimensions can be categorized as operational, tactical, and strategic aspects.

Another study highlighted significant differences in overall differential measures of return on assets (ROA) for ERP-adopting organizations than for the matched control organizations four years after ERP installation (Nicolaou & Bhattacharya, 2006). Obviously, differential ROA performance was significantly worse for ERP-adopting organizations in the first year of installation ended. Also in average expense ratios, the ratio of the cost of goods sold to sales was significantly lower for ERP-adopting organizations until four years after system implementation completion. This identifies that there can be seen a struggle in many organizations until sometime after implementation and again highlights the importance of clearly identifying the specific requirements needed and prioritizing them according to an allocated budget (Nicolaou & Bhattacharya, 2006). And when it comes to identifying specific requirements still many organizations struggle identifying the wanted and eliminating the unwanted. Some studies pointed out ERP adaptation is low among developing countries like Sri Lanka compared to much developed regions and reasons for this as costs associated

with implementation. Though some companies have identified the core required modules such as financials, assets and planning without integrating all the sub functions which result a successful implementation and ERP utilization won't happen and other organizations that adopted more than core modules have experienced problems again in using the system as well as in terms of cost factor. (Jayantha & Peter, 2005)

Today organization's invest huge amount of money on ERP systems and information systems, but question is do we get the full usage of the system we have or was the implemented system fulfill our expectations. Furthermore this research is more focused on identify the gap between expectations vs. reality in ERP post implementation. This is called the second wave by Chian-Son Yu in his study Causes influencing the effectiveness of the post-implementation ERP system (Yu, 2005)

When talking about the post implementation stage of ERP basically two components were addressed in this research.

- ERP Usage – Effective use of ERP
- ERP Maturity level – where your ERP stands

And a simple survey to identify the most commonly used ERP types in Sri Lankan manufacturing context was also carried out.

2.2. ERP Usage

ERP implementation and maintenance happen to be a costly process where some organizations doubt that though it's competitively and technologically must do, economically there is conflicting evidence suggesting it is difficult to justify the associated costs, and difficult to implement to achieve a lasting business advantage. However ERP value related studies have been conducted in some of the global researches using financial indicators such as return on assets or profitability (Nicolaou & Bhattacharya, 2006)which concluded that subsequent changes in ERP system often surface or resolve implementation issues that affect subsequent use of and success from the use of such systems. And though there are majority of failure stories there are many successful ERP adaptations as well.

There can be seen mixed evidence regarding the impact of ERP on organizational performance after implementation. In some cases there cannot be seen significant differences. For example, in a comparative study of financial performance of ERP adopter and non-adopter organizations, reported that there was no significant difference between two categories in terms of ratio of cost of goods sold to sales in many time periods after ERP implementation. Also it should be highlighted that the continuous monitoring related to the influence on ERP to the organizations' performance especially in after implementation stage has not been addressed much even in global context and there are not much of studies conducted on this aspect as well. This suggested the impotency of this study further. Another way to categorize usage is based on technology used & the use of data held in ERP systems (information role). For instance, to improve the existing process & to control the process ERP automation can be used, while the information role can help ERP users to use ERP systems for better decision support and better customer service (Lorenzo, 2001)

It is evident that actual ERP success relies on ERP usage and its benefits to the end users. ERP implementing firms have been continuously highlighted the low-usage from ERP end users. Simply it's the utilization of the system i.e. making practical and effective use.

Several prior studies have been conducted to identify the reason for that and ERP system usage and benefit: A model of antecedents and outcomes (Nwankpa J. K., 2014)stood out identifying several interesting factors on ERP usage which this research used to identify the usage level of ERP in this study. According to his study these factors were technology resources, organizational fit and knowledge integration mechanism which will lead to a better ERP system benefit. After some discussions with industry experts, to this research analytical capability of ERP for better decision making and collaborative use of ERP also were added as key factors of better ERP usage.

Technology Resources:

To any organization nowadays technical resources as well as information systems are very imported as they relay so much on these systems. Technical resources refer to the capabilities of technology that stands to maintain a smooth process in the organization in terms of operational requirements. In terms of maintaining better technical resources firms have several alignments, building and maintaining in-house system, using quality hardware and network applications, technology updates, software applications deployed etc. (Jennex, 2007)Also it is argued that the amount of new ideas to be deployed understood and implemented is influenced by the amount of available new technical knowledge and resources in an organization. (Dewar & Dutton, 1986) An organization generally has its own central function so in order to mitigate risks firms nowadays tend to get IT services from third party service providers. It has become a main reason why organizations leverage on vendors technical resources and skills in order to develop as well as maintain systems. (Aubert, Rivard, & Patry, 2004)Also, the world is moving towards cloud based technology in every information system possible. New ERP software will be built on innovating cloud architecture resulting massive computational opportunities as well as challenges in handling real time data. (Dikusar, 2018)

Business process fit

If the post implementation review process is well managed and identified corrections will lead to system enhancements (upgrades) in early stage of post implementation suggesting better organizational fit (Nicolaou & Bhattacharya, 2005) So, as mentioned above also it is required to identify what the requirement of the business and what will be the benefit of ERP for the process if only that component will be worthy of having in our ERP. It is commonly known that through better fit between information system architecture and the organization a better performance can be expected from ERP as well as from the benefiting organization. (Weill & Olson, 1989)
,

Knowledge integration, training on ERP

Another important thing that makes less usage of ERP is that lack of knowledge and appropriate training on ERP. Having proper knowledge as well as knowledge integration mechanisms and knowledge propagation methods will increase effective usage of ERP. There are two different types in business processes canonical and non – canonical. Where canonical stands for where complex tasks are mapped to simple steps which will result in proper training and on the other hand non-canonical means the activities that occur during work, informal processes defined by communication, relationships and co-ordination of job activities which will result knowledge sharing. (Brown & Dugiui, 1991).Especially after system update, in absorption of external knowledge and in job role replacements it's expected to have lot of knowledge integration and training on ERP if your organization rely so much on ERP. (Teo & Bhattacherjee, 2014)

Analytical capability of ERP for better decision making

Today world is moving towards with automation, AI technologies. What is the use of a system if it does not fit to our analytical requirements? Why we are using another program to perform our analytical requirements and do manual adjustments before using data for decision making? ERP generally has the ability to analyze data in the business operations. For instance, an ERP can help you predict demand, create a budget and analyze your HR functions also, these software capable of handling client data, production statistics, sales data and much more data analysis (Selecthub, 2019).

Collaborative ERP

Collaborative nature is a well-known feature in ERP. Since most ERP systems are based on same kind of information systems it is easy to collaborative features and functions between multiple ERP systems used within the organization or with suppliers, service providers as well as and even with customers. ERP systems currently do not use many collaboration capabilities and principles of collaboration should be used during system design stage to improve the usability of enterprise system. (Cooprider, Topi, Xu, Dias, Babaian, & Lucas, 2010) Also user interest of collaborative ERP has risen up in the past few years due to major software venders

promoting cost-cutting efficient customized ERP solutions which also lead to ERPs as an integrated module for existing system (Dikusar, 2018)

Overall ERP usage has been identified as a critical factor in post implementation issues which leads to ERP benefits. Though ERP systems are designed to collect, organize and interpret data in various businesses these processes are not used and it has led to various issues in ERP system usage.

2.3. ERP Maturity

The basic definition of maturity in ERP is highlighted as the basic condition of an organization's function which determines an upgrade or a downgrade in its ERP system increasing the probability of ERP success. (Scanzo, 2009) And the level of maturity can be measured in several ways, according to Andrea Scanzo (2009) it can be measured in terms of complexity and capacity.

- Complexity – Organizational characteristics that adversely influence the process of ERP
- Capacity – Organizational skills and capabilities to manage all the operational aspects of the ERP

According to this model key dimensions can be listed as; Project, organizational context, ERP implementation process and Risk management process.

Another study conducted in Brazil concluded that the level of maturity of an ERP in an organization could be influenced to gain competitive advantage among the companies that have implemented ERP. (Dias & Souza, 2004)

According to Saint Paul (2018) The Changing Role of ERP in Manufacturing, ERP systems are expected to extend their intended purpose:

He focused on few questions mainly;

- Why ERP attachments are not working for modern manufacturing environments?

- What are the common strategies for layering technology to drive manufacturing operations and supply chain strategies?

Greater digitalization, global competition and demand for more variety of products through customization which leads to adaptations of real time solutions in supply chain are some reasons that he highlighted in his study. (Paul, 2018)

Overall ERP maturity seems to be moving forward with the changing world's information systems. So, it is required us to have updated technology, skills and competences and knowledge as most of the manufacturing organizations in Sri Lanka are linked to foreign market.

The maturity model prepared by Holland & Light (2001) was the one which was more focused in this research. They identified three stages of maturity and prepared a scoring system to rank the organizations they focus the study. The authors classify the stage of maturity of an ERP implementation process using five theoretical constructs:

- Strategic Use of IT
- Organizational Sophistication
- Penetration of the ERP system
- Vision
- Drivers & Lessons

Using these five variables they produced a model which included three stages of maturity of ERP; Stage one: Organizations are managing legacy systems and starting the ERP project, stage two: After implementation the functionality of the ERP is expanded throughout the organization, stage three: using ERP as a value creation to the organization as well as using additional systems and ideas to create more value from ERP. (Holland & Light, 2000)

Next focus will be identifying the major ERP vendors in manufacturing organizations.

2.4. ERP Vendors

ERP vendors are those who have developed these ERP packages and they have license for establishing this in organizations according to their license regions. In global context there have been several key players and for years they have dominated the market. In Sri Lanka there are not much of research to be found in focusing much on the ERP vender distributions basically it's because here also in recent times, global vendors seems to dominate the market.

2.4.1. ERP Vendors in the Manufacturing Industry in the Global Context

Though there are significant emerging trends like cloud computing and automation related to in house developed ERP packages still the global market can be identified as a domination of SAP. Oracle, Microsoft and SAP together acquiring around 55% of market share and it's needed to highlight that 26% of the market is owned by several tier II vendors which proves us the major developments in customized ERP mentioned.

The market has been dominated by SAP, Oracle and Microsoft proving that they are still the leading service providers for ERP solutions. But several Tier II vendors also have had considerable market share. This lower end of the market has been segregated with 26% going to many vendors each of whom has less than 1% market share (CompareBusinessProducts, 2015), which highlights the emerging trend on in house developed solutions which provides customized versions for specific organizations which will obviously have better ERP usage and benefits but leading high associated costs than built in ERP packages.
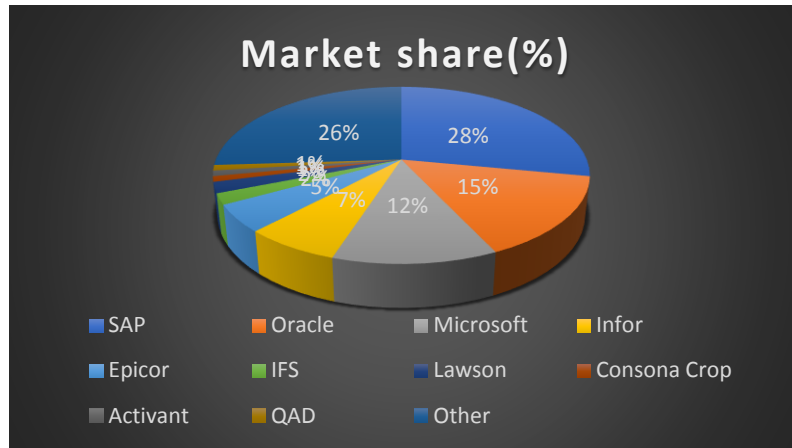
Figure 2.1: ERP Vendor distribution in manufacturing organizations in global context

Though relatively fewer articles can be found regarding Sri Lankan ERP vendor market, an analyzed was done by CA (institute of charted accountants Sri Lanka) in 2006 and below is their findings.
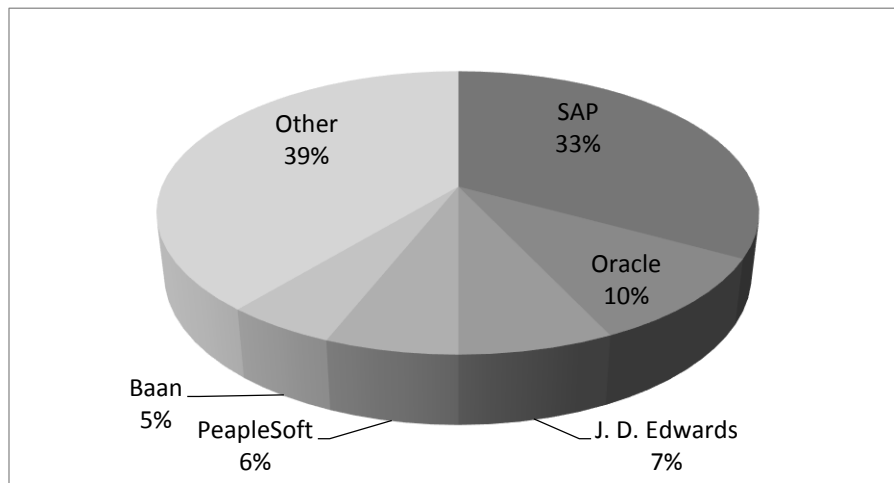
Figure 2.2: ERP Vendor distribution in manufacturing organizations in Sri Lankan context

SAP – It's a German multinational software corporation founded in 1972 by IBM Engineers. Its rational databases allow handling extremely complex business solutions. Over 180 countries across the globe they provide services to around 430,000 customers

Oracle - Somewhere around 2004, Oracle began to look at building its own ERP solutions and at the same time SAP began to offer its ERP solutions on the Microsoft SQL Server database platform. It's an American multinational computer technology corporation which is not only limited to ERP systems.

Microsoft - Microsoft Dynamics is more focused on tier II clients in the ERP space. In recent years Microsoft dynamics has been able to achieve a rapid market growth compared to other ERP vendors. As well as in other Microsoft products, Microsoft ERP is also well known for the easiness in handling.

And throughout the years these key players has been the main focus in ERP market. But today all these ERP software are rapidly changing due to new technologies like cloud based software solutions and automation (Paul, 2018)

As for the literature review, it is clear that the topic has been attractive in the global context but still a requirement for a proper analysis in the Sri Lankan context is missing. Therefore it is important to do a proper research on the maturity and usage of ERP in manufacturing organizations in Sri Lanka which will lead to many further researches as well as much needed information sharing to ERP using organizations.

3. RESEARCH METHODOLOGY

3.1. Introduction to research methodology

This chapter will be more focused on the procedure and the methods that the research has been taken to come out with the intended outcomes. In order to achieve research objectives, real world data should be extracted and this data should be extracted using validated statistical or mathematical techniques to prove the targeted outcomes. So

the research methodology will give the reader enough insight about the data collection, data analysis methods and the research limitations.

3.2. Research Model

This research is based on three main areas ERP Usage, ERP Maturity and ERP types in manufacturing organizations in Sri Lanka. The methodology will be based on how information is gathered on those areas. Focusing on those three areas methodology can be defined as a four-step approach.

- Building hypotheses to analyze ERP usage latent variables identified during the research literature among the population.
- Correlation to ERP usage with those latent variables.
- Building an appropriate maturity model to analyze the maturity of the population.
- Identification of the sample and data collection procedure.
- Sample data validation

The research in general was more focused on quantitative data analysis. And the first step was to identify the correlation between ERP usage and related latent variables that affect the ERP usage.

Five latent constructs were identified from prior research and those were used to capture the ERP usage in manufacturing organizations in Sri Lanka. And using another set of variables a maturity model was determined.

A population had to be identified which consisted the intended outcomes were applicable. Also a sample had to be chosen as to reflect the selected population. The population of this research was the manufacturing organizations in Sri Lanka in which an ERP system has been implemented.

The reason to select manufacturing organizations was that in supply chain management, manufacturing has the highest contribution in implementation of ERP systems. This is mainly due to two reasons; manufacturing companies were the earliest

adopters of ERP systems and also once they are implemented it is said to be they are not easily updated neither replaced (Gheorghiu, 2018). When it comes to this particular research area no researches can be found in Sri Lankan context which highlighted a gap in this particular area and also lack of researches in post implementation issues can be highlighted as some reasons to do this research. And this research intended to extend the findings of the two researches, ERP system usage and benefits done by Joseph K. Nwankpa(2015) and International Analysis of the Maturity of ERP Systems Use done by Christopher P. Holland & Ben Light(2000).Using them as a foundation will help to extended their findings to Sri Lankan manufacturing context.

3.2.1. Sample Design

Sample selection was critical, needed one which will be able to generalize the results acquired investing the sample to the population. According to the methodology used for the analysis, a minimum of 30 responses were enough to provide accurate results. So the sample size had to be at least 30.

For this study as manufacturing organizations were used, based on a leading business magazine LMD best manufactures as per year 2018 were selected. Thus the survey was conducted covering the majority of users in manufacturing industry.

3.2.2. Data collection

To collect data an online questionnaire was used and the basic structure included variables to extract data for the three main areas in the research the ERP type, ERP usage and ERP maturity. The questionnaire was designed in such a way that data can be extracted for the variables considered throughout the research and mainly it was following the above mentioned two researches as guidelines.

The questionnaire was categorized basically to three main categories and these categories then were categorized to sub categories consisting latent variables. Using prior interviews with few industry experts and questions were built. Then these questions aiming those sub categories were sent to end users of ERP to get responses.

ERP type and general data about the ERP was captured through straightforward questions and to identify ERP usage and ERP maturity following latent variables were used.

- ERP Usage
  - Technical Resources
  - Business Process Fit
  - Knowledge, training on ERP
  - Analytical capability of ERP for better decision making
  - Collaborative ERP

- ERP maturity
  - Strategic use of IT
  - ERP Integration on components of value chain
  - ERP Utilization / benefits
  - Best practices
  - Lessons, innovations on ERP

Table 3.1: Indicator variables in the questionnaire for each latent variable for ERP usage

latent variable	Indicator Variable in the questionnaire	Icon
Technical Resources	ERP updating frequency	T1
	Using updated technology	T2
	IT external support	T3
	Recovery system	T4
	Ability/Knowledge to enhance ERP	T5
Business Process Fit	User Friendliness of ERP	B1
	Data Downloading Frequency from ERP	B2
	Visibility of relevant data throughout the organization	B3
	Format of ERP matching the business requirement	B4

	Process flow in ERP	B5
Knowledge, training on ERP	Interest in working with ERP	K1
	Training programs	K2
	Employee turnover due to difficulty in handling ERP	K3
	Knowledge sharing among employees	K4
	Employee interference in ERP modification	K5
Analytical capability of ERP for better decision making	Using ERP for operational and managerial requirements	A1
	Trust with the system	A2
	System audits for quality data	A3
	ERP impact on business data handling	A4
	No support software required for data analysis	A5
Collaborative ERP	Visibility to relevant data for collaborative suppliers	C1
	Visibility to relevant data for collaborative service providers	C2
	Use of integrated Information system in the end though used multiple ERPs	C3
	Using Same ERP throughout the organization	C4
	Customized functions for our internal requirements	C5

To collect data about the ERP usage the responses were recorded on a five point Likert scale ranging from Strongly Disagree/Most unlikely (represented as 1) to Strongly agree/mostly Likely(Represented as 5). Before sending out the questionnaire a pilot run as well as few interviews was done with the industry experts prior to preparation of the questionnaire.

The online questionnaire was sent to identify sample via e-mail and through social media and sent reminders after 1 weeks' time. A total of 48 questionnaires were sent to companies and 30 valid responses were received. Therefore the response rate stands at 62% which is a really good rate in terms of online questionnaires.

Based on literature, maturity model consist five main variables and these variables were measured through separate set of variables as indicator variables in the questionnaire. Below table 3.2 illustrates the variables used

Table 3.2: Indicator variables in the questionnaire for each latent variable for ERP maturity

latent variable	Indicator Variable in the questionnaire	Icon
Strategic use of IT	IT team Identifying the core requirements for ERP modification	S1

	Management Representation in Strategic ERP related decisions	S2
	Having an updated and knowledgeable IT team about ERP	S3
ERP Integration on components of value chain	ERP data integration	I1
	ERP used for decision making	I2
	ERP aligning the organization process	I3
ERP Utilization / benefits	ERP data usage per week	U1
	ERP positive impact on operation performances	U2
	ERP Usage and idea about ERP	U3
Best practices	maintain a business continuity plan	P1
	System audits for data quality	P2
	Real time data visibility for employees	P3
Lessons, innovations on ERP	Investments on continuous improvement on ERP	L1
	Frequency of ERP modification	L2
	Feedback system and tracking system on data entry	L3

3.3. Data Analysis Methods

In data analysis methods for main two research areas ERP usage and ERP maturity, different data analyzing methods were used. For ERP usage hypotheses testing was used and using these hypotheses ERP usage was evaluated. For that first observed variables in the sample using the questionnaire was computed to a scale score using SPSS (Statistical Package for the Social Sciences) and this scale was used to check the hypotheses using multiple regression analysis along with an exploratory factor analysis. The reason was to use explanatory factor analysis was to get a clear idea about the reliability or correlation between measured variables and latent variables in the built hypotheses and using regression further analysis was done. Here multiple regressions was carried out because we had several variables as predictors and ERP usage only, as the criterion variable. Next for maturity model a simple rank scale was developed based on literature and this scale produced a graphical model to identify the maturity levels. Here 14 questions were asked from the respondent each having a rank from 1 to 5 in terms of importance for his organization perspective. Rank 1 indicated that this specific attribute is note important at all and rank 5 indicated its extremely important to he/her organization.

The analysis had several important steps. First using Microsoft Excel 2010 data was screened out to remove missing values and invalid responses. To identify any abnormalities of the collected responses Kurtosis analysis was done. Then to check the correlation of indicator variables in the questionnaire using a Cronbach's Alpha test followed by an explanatory factor analysis were used. The explanatory factor analysis was done using principle component analysis (PCA) which helped to narrow down the large set of variables in to our desired variable set. Validity of sample is to be checked by sample to variable ratio(N:p). Ranging in any of 3:1, 6:1, 10:1, 15:1, or 20:1 is said to be within the range. (Hogarty, Hines, Kromrey, Ferron, & Mumford, 2005) .Where N stands for the number of participants and p stands for the number of variables. In this case there were 30 responses to 5 variables so that N: p ratio is 6:1 which is within the acceptable range. All the statistical tests were carried out using SPSS 13.0 version and excel 2010 only.

According to the factor analysis, for the variables that fit together Cronbach's alpha test was conducted afterwards. Cronbach's alpha test is used to measure the internal consistency of a set of data which measures the closeness of the data set to each other and the reliability of the scale. For each set of observed variables according to the latent variables represented by them and required adjustments were done to improve the reliability of the scale.

After identifying the latent variables mean values hypotheses tests were done to check the ERP usage over these five variables. For this multiple regressions was used with R^2 test, p-value and F test.

3.3.1. Hypotheses Development

Hypotheses were built to identify the correlation or the covariance between selected variables and ERP usage. For that purpose five hypotheses were built using the literature studied and interviews conducted with industry experts.

First three hypotheses H1, H2, H3, were built based on study conducted on ERP system usage and benefit: A model of antecedents and outcomes (Nwankpa J. K., 2014). He highlighted technological resources, ERP fit to the business process and knowledge

integration as main areas that influence for better ERP benefit. The other two hypotheses H4 and H5 were built after discussing with few industry experts regarding ERP usage in current Sri Lankan manufacturing context. When caring out these interviews both ERP users and ERP service providers were used.

H1: Firms having more technological resources tend to have more ERP usage.

H2: Firms having a greater degree of business process fit with the standard ERP outcomes are more likely to USE ERP.

H3: Firm with effective training programs, knowledge integrations efficiently are more likely to have better usage of ERP.

H4: Analytical capability of ERP will result a higher ERP usage and hence better decision-making procedures.

H5: Greater collaborative ERP systems will result better usage of ERP, increasing efficiency.

Using multiple regression analysis was used to analyze the relationship between latent variables and ERP usage to test above hypotheses finally.
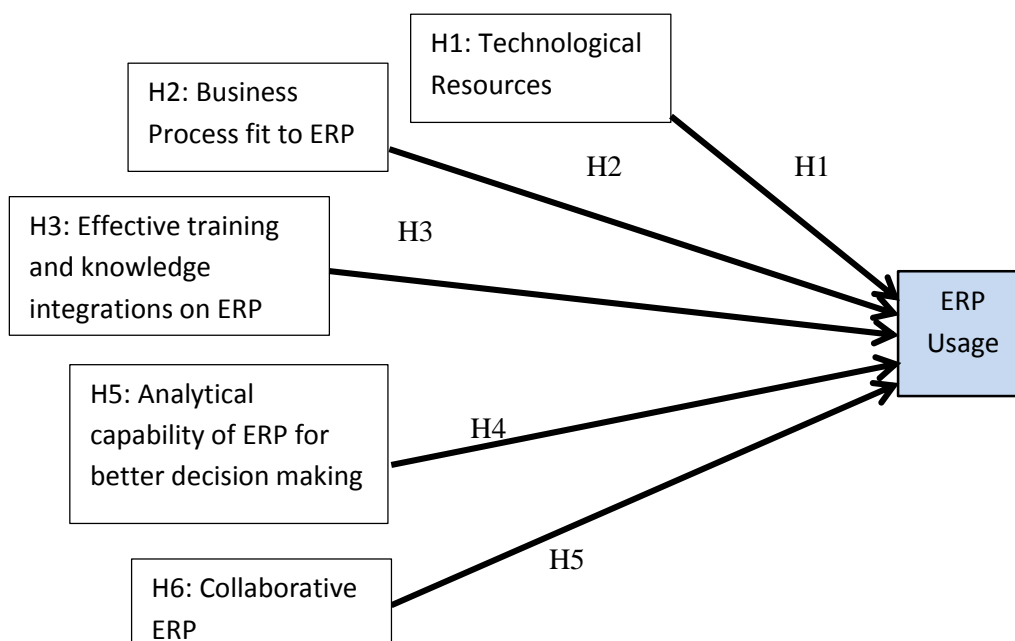
Figure 3.1: Hypotheses developed to test the conceptual model

4. RESEARCH FINDINGS

4.1. Data Screening

30 valid responses were collected from the population and there were no missing values or rejected responses. So, all the responses were collected and first checked the mean and the standard deviation of each data variable in the questionnaire. All the variables measured in the questionnaire had standard deviation above 0.5 which fulfilled the research criteria of rejecting in any case, if standard deviation was less than 0.5 (Appendix 1). The screening of variables was done afterwards and there were no missing variables. The responses do not have any issues with skewness as all the data lies within -1 and +1 which suggests that the distribution is symmetrical in nature and Kurtosis analysis suggested that all variables were < 3 (less than 3) suggesting flat curves. However, the data were in acceptable range. (Elsevier, 2014).According to the methodology the survey was conducted in main three areas, ERP type, ERP usage and

ERP maturity. First focus will be on general data which reveals ERP type related data and the descriptive statistics about the attributes of the sample.

4.1.1. Sample Demographics

- **ERP type**

As you can see in figure 4.1, the majority, more than 50% was SAP users and around 13.3% each was oracle and Microsoft, the rest belongs to other tire II ERPs. Also was evident that some users use multiple main ERPs like SAP and Oracle as well as SAP and IFS.
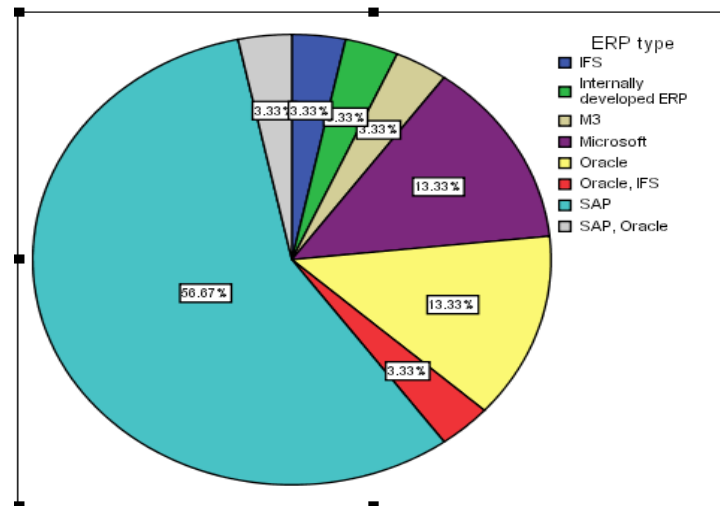
Figure 4.1: ERP type distribution

- **Industry Type**

According to the industry type, majority is from FMCG (Fast Moving Consumer Goods) and in textile. Those two represent more than 60% in the sample indicating
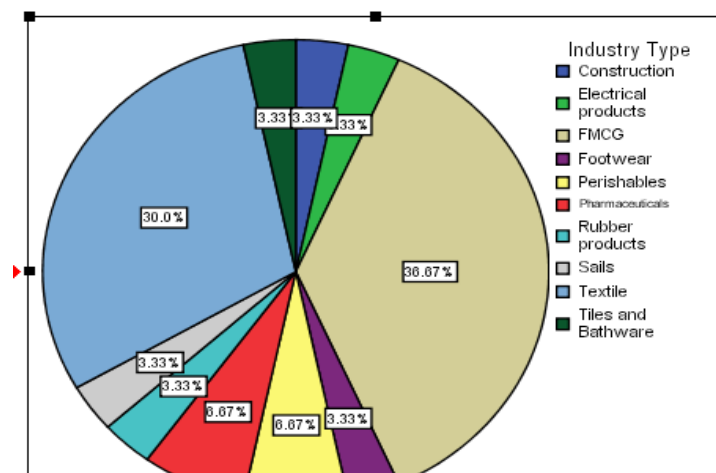
Figure 4.2: Industry type

majority of ERP users in manufacturing sector.

- **ERP Change/update requirement**

According to the sample data 70% of the respondents think that the ERP currently they are having needs to be updated or modified. Figure 4.1.3 shows individual requirement on updating their organizations' ERP
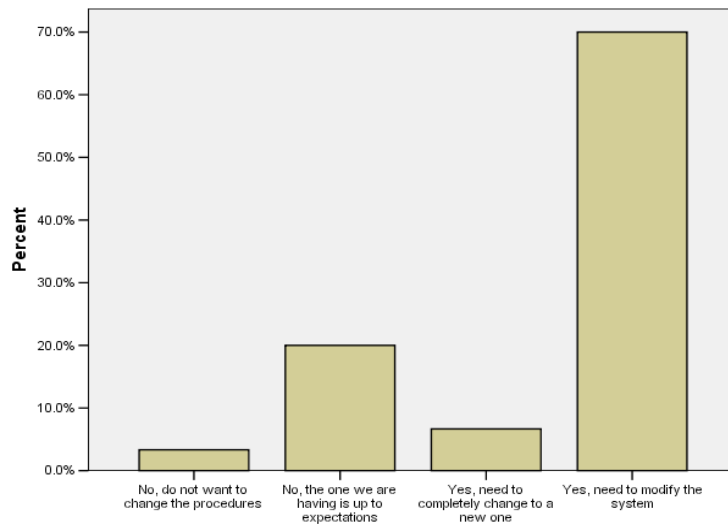
And around **Figure 4.3: ERP modifying requirement** 10% think that ERP needs to be changed completely resulting only 20 % of the sample been comfortable with the current system. Meanwhile it's interesting to see that some of the respondents implying that they 'do not want to change the current procedure'.

- **ERP used time range of users in the sample**

According to below bar chart majority of the sample had ERP experience between 1 -3 years and it's more that 40% of the sample. Around 35% of the sample had ERP experience for more than 5 years.
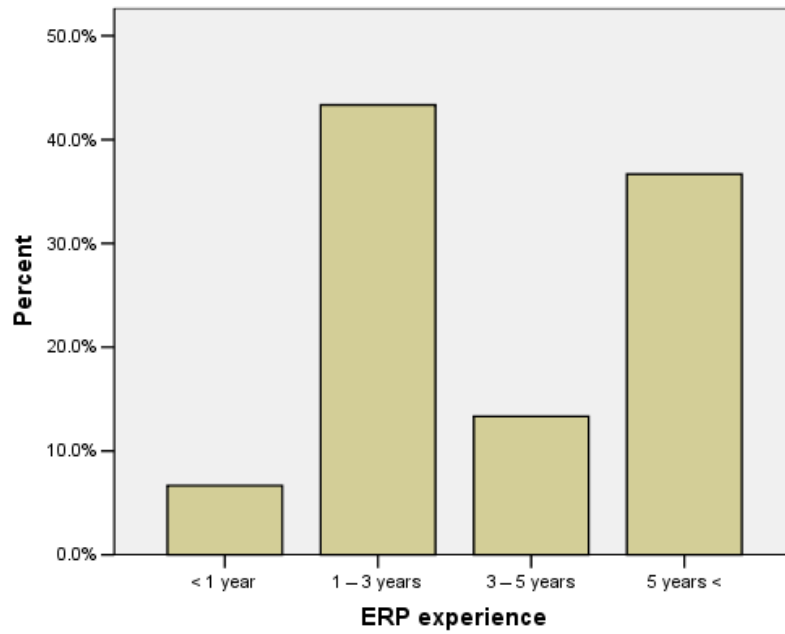
Figure 4.4: ERP user experience in years

- **Satisfaction level of ERP**

According to collected data majority of the users are somewhat satisfied with the current ERP in their firms. To be precise 60% of the sample was in this category. Also it was identified that 20% of the respondents were unsatisfied and only around 5% were very satisfied with the ERP they have.
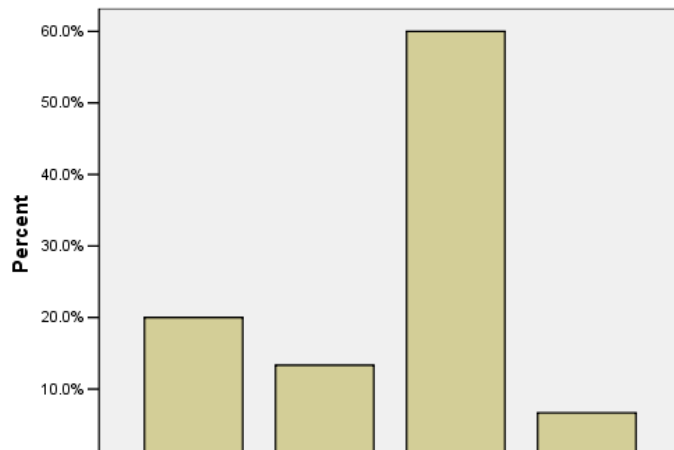
Figure 4.5: ERP user satisfaction level

4.2. Descriptive Analysis

First focus will be on ERP usage. And based on five latent variables observed variables descriptive statistics will be discussed here.

4.2.1. Technical Resources

Table 4.1: Observed results of technological resources

latent variable	Indicator Variable in the questionnaire	Icon	Mean	Standard Deviation
Technical Resources	ERP updating frequency	T1	3.87	0.82
	Using updated technology	T2	3.80	1.19
	IT external support	T3	4.07	1.17
	Recovery system	T4	4.03	0.99
	Ability/Knowledge to enhance ERP	T5	3.50	1.07
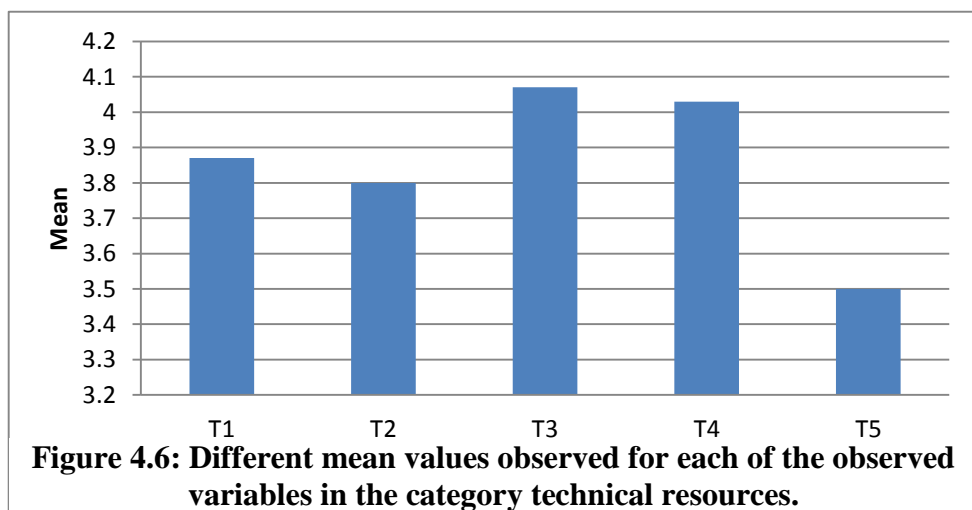
Figure 4.6: Different mean values observed for each of the observed variables in the category technical resources.

According to the descriptive data it seems most of the leading manufacturing organizations tend to use much advanced technology resources that are available in Sri Lankan market. It seems there is a slight lack in ability and knowledge in enhancing ERP structure though as the mean stands slightly above average in T5 variable.

4.2.2. Business Process Fit

Table 4.2: Observed results of Business Process Fit

latent variable	Indicator Variable in the questionnaire	Icon	Mean	Standard Deviation
Business Process Fit	User Friendliness of ERP	B1	3.70	0.95
	Data Downloading Frequency from ERP	B2	4.23	0.77
	Visibility of relevant data throughout the organization	B3	3.80	0.96
	Format of ERP matching the business requirement	B4	3.67	0.99
	Process flow in ERP	B5	3.93	0.69
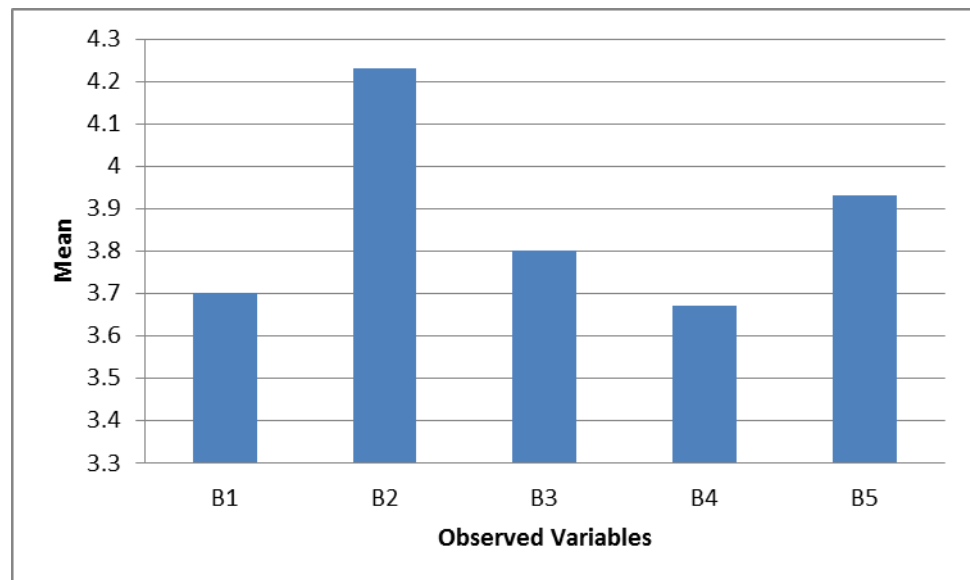
Figure 4.7: Different mean values observed for each of the observed variables in the category Business Process Fit

In this case though the variation of means of these observed variables fluctuate lot more than previous case all of them are above the average which shows us that the organizations we studied use ERPs that fit much to their business process.

4.2.3. Knowledge, training on ERP

Table 4.3: Observed results of Knowledge, training on ERP

latent variable	Indicator Variable in the questionnaire	Icon	Mean	Standard Deviation
Knowledge, training on ERP	Interest in working with ERP	K1	3.63	0.93
	Training programs	K2	3.43	1.07
	Employee turnover due to difficulty in handling ERP	K3	2.80	1.09
	Knowledge sharing among employees	K4	3.60	0.93
	Employee interference in ERP modification	K5	3.80	1.09
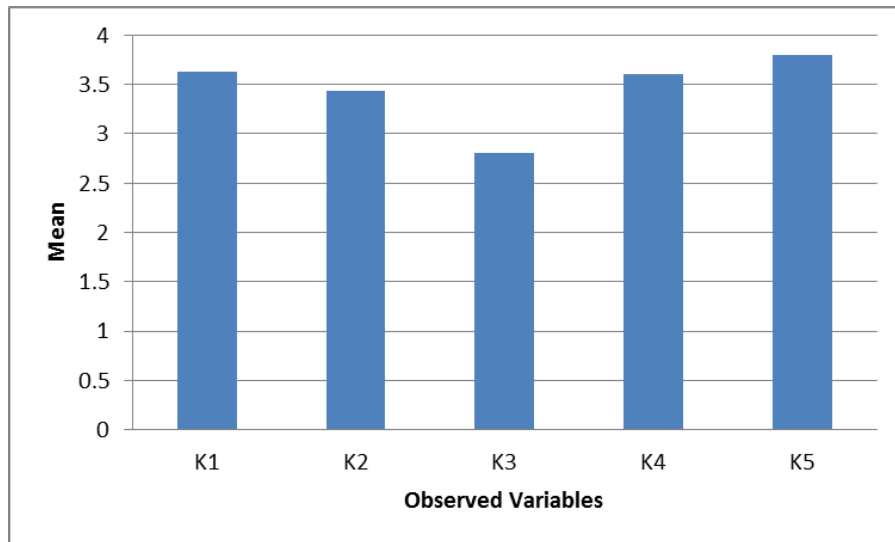
Figure 4.8: Different mean values observed for each of the observed variables in the category Knowledge, training on ERP

According to above table and figure output variable K3; Employee turnover due to difficulty in handling ERP has a below average outcome showing less connectivity to the latent variable.

4.2.4. Analytical capability of ERP for better decision making

Table 4.4: Observed results of Analytical capability of ERP for better decision making

latent variable	Indicator Variable in the questionnaire	Icon	Mean	Standard Deviation
Analytical capability of ERP for	Using ERP for operational and managerial requirements	A1	3.90	0.89
	Trust with the system	A2	3.83	0.83

better decision making	System audits for quality data	A3	4.13	0.57
	ERP impact on business data handling	A4	3.47	1.07
	No support software required for data analysis	A5	3.60	0.93
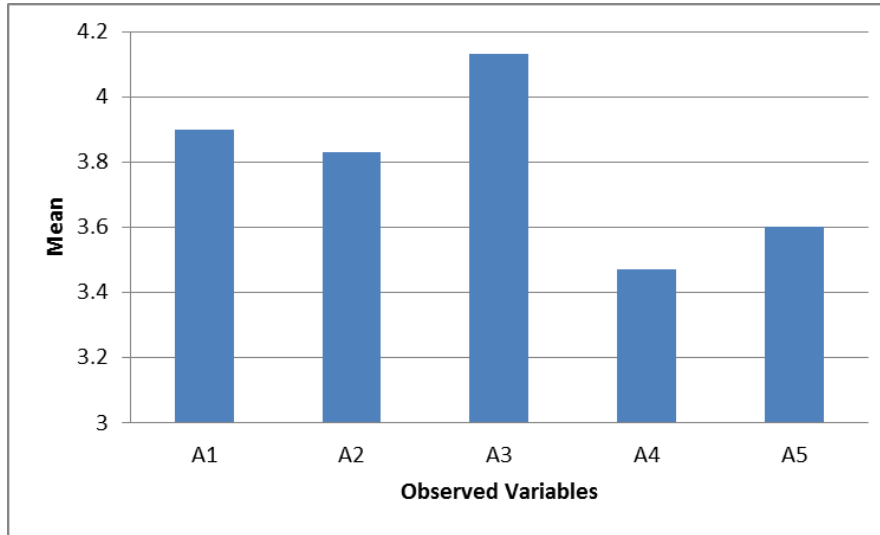
Figure 4.9: : Different mean values observed for each of the observed variables in the category Analytical capability of ERP for better decision making

According to the figure 4.2.4, all the results are above the average and last two variables seems to be slightly above average suggesting least impact on Analytical capability of ERP.

4.2.5. Collaborative ERP

Table 4.5: Observed results of Collaborative ERP

latent variable	Indicator Variable in the questionnaire	Icon	Mean	Standard Deviation
Collaborative ERP	Visibility to relevant data for collaborative suppliers	C1	2.97	1.25
	Visibility to relevant data for collaborative service providers	C2	3.13	1.31
	Use of integrated Information system in the end though used multiple ERPs	C3	2.57	1.12
	Using Same ERP throughout the organization	C4	4.07	0.79
	Customized functions for our internal requirements	C5	3.97	0.85
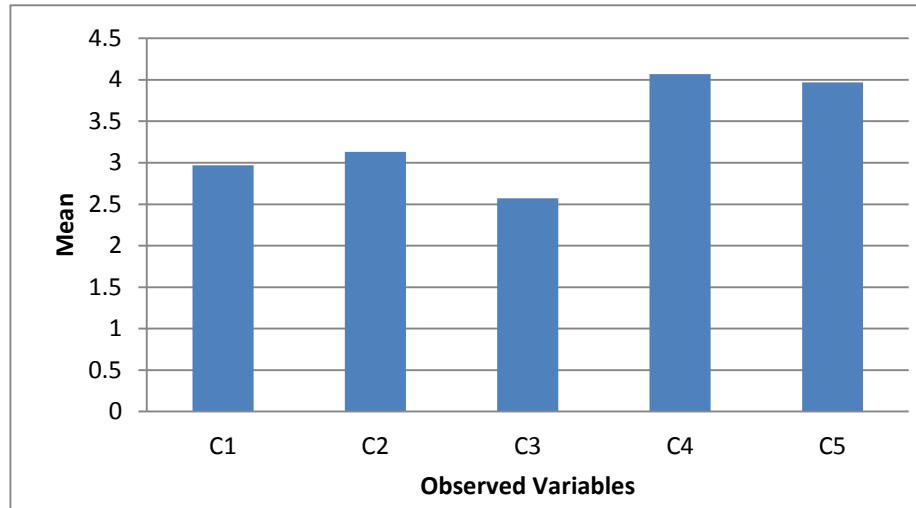
Figure 4.10: Different mean values observed for each of the observed variables in the category collaborative ERP

As shown in figure 4.2.5, when collaborative ERP category is considered several variables measured shows below average values, Visibility to relevant data for collaborative suppliers, integration in multiple ERPs etc. suggesting less connection to collaborative ERP hence less use of collaborative ERP usage in leading manufacturing organizations in Sri Lanka.

Next focus will be on descriptive analysis of maturity related data.

4.2.6. **Maturity Model**

Table 4.6: Observed results of Maturity Model

latent variable	Indicator Variable in the questionnaire	Icon	Mean	Standard Deviation
Strategic use of IT	IT team Identifying the core requirements for ERP modification	S1	3.20	1.35
	Management Representation in Strategic ERP related decisions	S2	3.70	0.95
	Having an updated and knowledgeable IT team about ERP	S3	3.80	0.96
ERP Integration on components of value chain	ERP data integration	I1	3.73	0.94
	ERP used for decision making	I2	3.83	0.91
	ERP aligning the organization process	I3	3.63	0.99
ERP Utilization / benefits	ERP data usage per week	U1	3.47	1.07
	ERP positive impact on operation performances	U2	3.80	0.96

	ERP Usage and idea about ERP	U3	3.50	0.94
Best practices	maintain a business continuity plan	P1	3.50	1.01
	System audits for data quality	P2	3.40	1.16
	Real time data visibility for employees	P3	3.47	1.14
Lessons, innovations on ERP	Investments on continuous improvement on ERP	L1	3.63	0.81
	Frequency of ERP modification	L2	3.27	0.91
	Feedback system and tracking system on data entry	L3	3.57	0.94
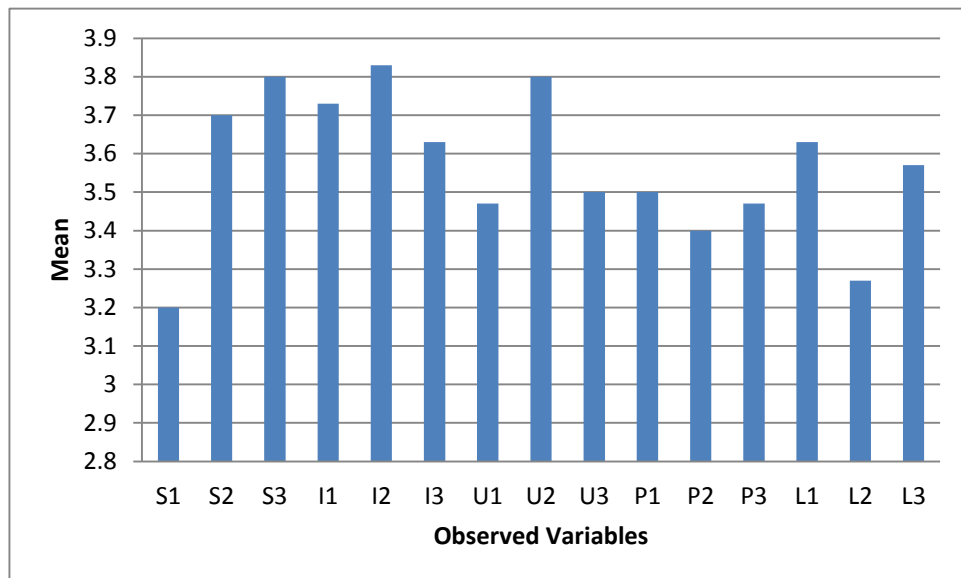
Figure 4.11: : Different mean values observed for each of the observed variables in maturity model's observed variables

When considering the distribution of means in each and every observed variable in maturity model as shown in above figure, it's evident that almost all the means lie between 3.1 and 3.9 suggesting majority of the sample distributed around the average value of 3 indicating that the impotence given by the organization towards the maturity of ERP, neutral. All these slightly above the central point of 3 so that we can use in our model but the influence of these variables seems to be less.

4.3. Reliability Measures

4.3.1. Cronbach's alpha Test

The Cronbach's alpha showed a value of 0.877 in ERP usage related data and 0.881 in maturity model's data suggested that the data collected were reliable enough to carry out the research as it's higher than 0.70 (Solutions, 2019)

Reliability Statistics for ERP Usage data

Table 4.7:Result of Cronbach's alpha for ERP usage

Cronbach's Alpha	N of Items
.877	25

Reliability Statistics for ERP maturity data

Table 4.8: Result of Cronbach's alpha for ERP maturity

Cronbach's Alpha	N of Items
.881	15

4.4. Exploratory Factor Analysis

The exploratory analysis was only conducted to the ERP usage related data. The Kaiser-Meyer-Olkin(KMO) ratio of sampling was 0.520 which suggests that the sample was marginally adequate to provide valid results. Barlett's Test of Sphericity has a Significant value less than alpha(0.05).Both these outcomes suggested that the variables considered have correlations which makes it appropriate for factor analysis.

Table 4.9: Results of the KMO and Bartlett's Test

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.520
Bartlett's Test of Sphericity	Approx. Chi-Square	493.627
	df	300
	Sig.	.000

All community values were above 0.65 with a minimum value of 0.678 and maximum of 0.926 concluding that the variables which remain fits well with the factor solutions.

Table 4.10: Results of the communalities

Communalities

	Initial	Extraction
T1	1.000	.769
T2	1.000	.678
T3	1.000	.712
T4	1.000	.669
T5	1.000	.773
B1	1.000	.757
B2	1.000	.845
B3	1.000	.896
B4	1.000	.804
B5	1.000	.852
K1	1.000	.880
K2	1.000	.811
K3	1.000	.926
K4	1.000	.748
K5	1.000	.860
A1	1.000	.870
A3	1.000	.754
A4	1.000	.704
A5	1.000	.886
C1	1.000	.887
C2	1.000	.876
C3	1.000	.711
C4	1.000	.694
C5	1.000	.729
A2r	1.000	.882

Extraction Method: Principal Component Analysis.

Table 4.11: Pattern Matrix extracted by the Exploratory Factor Analysis

	Factor						
	1	2	3	4	5	6	Observed variable description
K5	.814						Employee interference in ERP modification
B4	.786						Format of ERP matching the business requirement
K4	.748						Knowledge sharing among employees
B2	.729						Data Downloading Frequency from ERP
B1	.679						User Friendliness of ERP
B3	.667						Visibility of relevant data throughout the organization
K1	.628						Interest in working with ERP
A1		.857					Using ERP for operational and managerial requirements
A3		.726					System audits for quality data
A2r		.698					Trust with the system
A4		.565					ERP impact on business data handling
A5		.528					No support software required for data analysis
C1			.848				Visibility to relevant data for collaborative suppliers
C2			.667				Visibility to relevant data for collaborative service providers
C5			.636				Customized functions for our internal requirements
C3			.504				Use of integrated Information system in the end though used multiple ERPs
T4				.720			ERP updating frequency
T1				.665			Recovery system
T3				.660			IT external support
C4					.821		Using Same ERP throughout the organization
B5					.740		Process flow in ERP
K3						.821	Employee turnover due to difficulty in handling ERP

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.

a. Rotation converged in 8 iterations.

Latent variable Descriptions

K - Knowledge, training on ERP
B - Business Process Fit
A - Analytical capability of ERP for better decision making
C - Collaborative ERP
T - Technical Resources

According to above pattern matrix factor one consists of variables from both Business Process fit and knowledge, training on ERP. Other three factors combine variables in next three latent variables - Analytical capability of ERP for better decision making, Collaborative ERP and Technical Resources respectively. Another additional two factors have been highlighted in this matrix where one relates with the dataflow of the ERP and a separate one variable factor regarding employee turnover due to handling issues in ERP. The convergent validity of the variables were acceptable only if coefficient was above 0.5 and minimum value 0f 0.504 and beyond were accepted. Accordingly below correlation matrix was obtained which does not show any significant correlation between factors as per the thumb rule, any factor correlation below 0.7 is not considered as significant.

Table 4.12: Factor Correlation Matrix extracted by Exploratory Factor Analysis

Component Transformation Matrix

Component	1	2	3	4	5	6
1	.719	.416	.419	.324	.170	-.016
2	.125	-.489	.367	-.456	.627	-.097
3	-.214	.708	.158	-.652	.023	-.034
4	-.468	.259	-.071	.458	.618	-.343
5	.236	.135	-.622	-.097	.442	.578
6	-.382	-.008	.522	.206	.028	.734

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.

After identifying the factors Cronbach's alpha test were carried out to test the reliability of these underlying variables in the factors and the last factor (Factor6 in the Pattern Matrix) was ignored because it was a separate variable which goes not had links with the other variables

Table 4.13: Cronbach's Alpha test results for each of the latent variables

Latent variable	No. of indicator variables	Cronbach's Alpha
Business Process fit and knowledge, training on ERP	7	0.882
Analytical capability of ERP for better decision making	5	0.778
Collaborative ERP	4	0,759
Technical Resources	3	0.710

Data flow of the ERP	2	0.732

4.5. Regression Analysis

As for the objective of the research, to find the relationship between latent variables and ERP usage a multiple regression analysis was then carried out for the factors identified from exploratory factor analysis above.

Table 4.14: Modal summary table of factors with ERP usage

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.815(a)	.664	.594	.573

a. Predictors: (Constant), AC, DF, TR, BPF_KT, Coll_ERP

After computing a scale using SPSS latent variables' values were detected using the appropriate observed variables identified from factor analysis. Namely these variables were BPF_KT – Business Process Fit and Knowledge, Training on ERP, AC – Analytical Capability, Coll_ERP – Collabarative ERP, TR – Technical Resources and DF - Data flow of the ERP. Above table shows the R^2 value of 66.4% indicating that these variables are 66.4% accountable for the ERP usage in the sample and also a high level of correlation between ERP usage and these factors as well.

Table 4.15: Anova table of Multiple Regression model on ERP Usage

ANOVA(b)

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	15.574	5	3.115	9.472	.000(a)
	Residual	7.892	24	.329		
	Total	23.467	29			

a. Predictors: (Constant), AC, DF, TR, BPF_KT, Coll_ERP
b. Dependent Variable: ERP_Usage , Test using Alpha = 0.05

The ANOVA results can be interpreted as significant because $F_{(5,24)}=9.47$, $p < 0.001$, $R^2 = 0.66$. According to these results below hypotheses can be accepted and it was evident that the new variable Data flow of ERP was also related to ERP usage in the sample data.

Table 4.16: Results of coefficients in each factor

Coefficients (a)

Model	Unstandardized Coefficients		Standardized Coefficients		
	B	Std. Error	Beta	t	Sig.
1 (Constant)	-2.683	.975		-2.752	.011
BPF_KT	.190	.182	.153	2.358	.027
Coll_ERP	.127	.153	.124	2.082	.046
TR	.333	.150	.277	2.219	.036
DF	.526	.141	.478	3.743	.001
AC	.515	.220	.326	2.342	.028

a. Dependent Variable: ERP_Usage

According to individual coefficient values in all five variables from confidents table 4.1.6 above, since all of theirs significance values are less than test statistic Alpha(0.05) all the hypotheses were accepted.

Table 4.17: : Results of the Hypothesis Test

| Hypotheses	Result
H1: Firms having more technological resources tend to have more ERP usage.	Supported
H2: Firms having a greater degree of business process fit with the standard ERP outcomes are more likely to USE ERP.	Supported
H3: Firm with effective training programs, knowledge integrations efficiently are more likely to have better usage of ERP.	Supported
H4: Analytical capability of ERP will result a higher ERP usage and hence better decision-making procedures.	Supported
H5: Greater collaborative ERP systems will result better usage of ERP, increasing efficiency.	Supported

4.6. Maturity Modal

The maturity model was based on five latent variables. These latent variables were linked to observed variables in the question and first a simple Cronbach's alpha test was carries out to check the reliability in each set of these variables and it showed that

the all observed variables linking the latent variables had reliability measures above 0.7 suggesting that the data was reliable.

Next a scale was prepared for each latent variable considering the mean of observed variables and this scale produced a score on each respondent to each latent variable and finally a total score. This total score was the plotted against the respondent to get the maturity model.

Table 4.18: ERP Maturity Scores for research sample

Respondent	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Strategic use of IT	3	5	3	3	3	4	2	5	5	3	4	5	3	3	5	4	4	5	4	3	3	5	3	2	5	4	3	4	4	3
ERP Integration	4	5	3	3	3	4	3	4	5	3	4	4	2	3	5	4	5	5	3	4	4	4	3	3	4	4	4	4	5	5
ERP Utilization & benefits	3	5	4	2	3	3	3	4	5	3	5	4	2	2	3	4	5	4	5	4	4	4	3	4	4	3	3	3	4	4
Best Practices	4	5	4	2	3	3	3	4	4	3	4	4	2	3	4	5	4	1	2	4	4	4	2	4	4	4	3	5	4	3
Lessons & Innovations	4	5	4	2	3	4	3	4	4	2	4	4	3	3	3	4	4	3	4	4	3	4	2	3	4	4	4	4	4	5
Total_Score	18	25	18	12	15	18	14	21	23	14	21	21	12	14	20	21	22	18	18	19	18	21	13	16	21	19	17	20	21	20
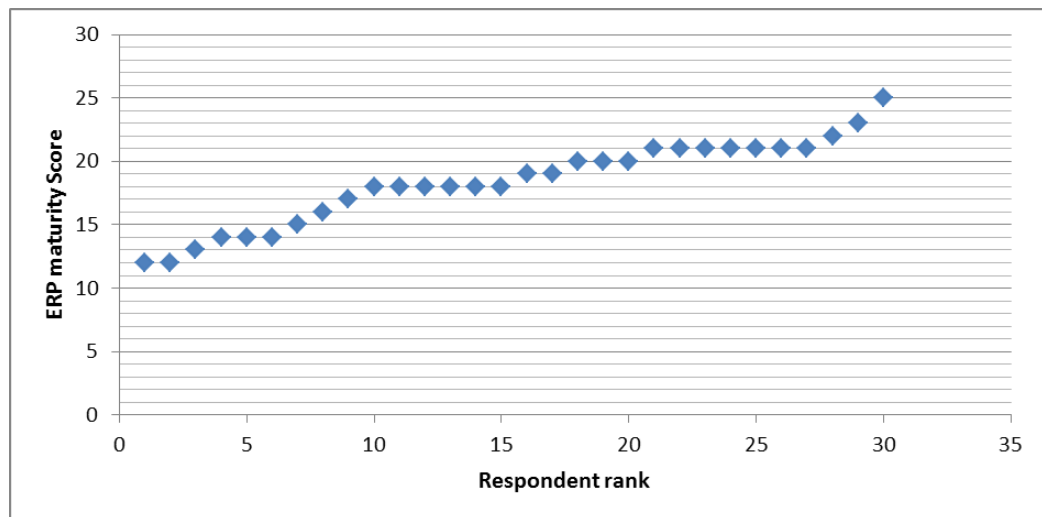
Figure 4.12: ERP Maturity Scores of Research Sample

As per figure 4.6.1, this model it seems to have the shape of the 'S' curve which was based on the literature maturity model, an International Analysis of the Maturity of Enterprise Resource Planning (ERP) Systems Use (Holland & Light, 2000).

As each variable was calculated on an average measurement based on the respondent given score and the minimum amount one can give was 1 – very little important. So as

there were 5 latent variables considered minimum total score was to be expected at 5. According to literature if the score is seven or less than that it can be considered as in stage one. And up to total score of 22 it is conserved as stage 2 and from score level of 23 to 25 it is considered as stage three. In this model stage one is referred as the implementation stage where companies either are in middle of implementation or getting ready for near future implementations. Stage two is defined as where organizations are in after implementation adaptation stage where they try to get used to the ERP. Final stage three is where ERP modifications and lesson driven enhancements are happening.

According to this sample, the concentration of the middle phase was much higher than expected. According to the curve it seems that there are few companies which are in stage three, those which looking for innovative ideas and developments in ERP. But majority of the sample lies in stage two where still ERP adaptation is happening. And it's quite interesting to see there are no stage one organizations can be seen in the sample.

5. DISCUSSION

This study was carryout to get an insight about ERP usage in and maturity in manufacturing organizations of Sri Lanka. Basically the target population was the organizations where already ERP systems were implemented. Considering that the

focused sample was top performing manufacturing organizations according to LMD data.

Basic two models designed by previous researches were the foundation for the study. ERP usage analysis was based on five developed latent variables and using hypotheses these variables were analyzed to find out whether there is a relationship between ERP usage and these variables. And it was found to be these identified factors were directly influential to the ERP usage. The other model did a surface analysis on ERP maturity and was able to highlight that the maturity level of ERP systems in manufacturing context of Sri Lanka still lies in second stage where the after adaptation procedure was going on.

5.1. Summary of Findings

The explored literature in the research guided in finding the latent variables in maturity model as well as in identifying the factors affecting ERP usage. These factors of course provided a broader scope to the research and also became the foundation for the research. This research was inspired by two researches ERP system usage and benefit: A model of antecedents and outcomes (Nwankpa J. K., 2014) and An International Analysis of the Maturity of Enterprise Resource Planning (ERP) Systems Use (Holland & Light, 2000) where similar research was done focusing Europe and USA.

The exploratory factor analysis extracted several factors from the questionnaire which contributed directly towards latent variables identified from literature. In this phase some of the observed variables from the questionnaire had to be dropped to get a significant relationship between factors. These factors were later used to analyze hypotheses developed and below shows the extracted factors and their relationship to observed variables.

Table 5.1: Extracted factors from the Exploratory Factor Analysis

Factor 1	Employee interference in ERP modification	K5
	Format of ERP matching the business requirement	B4
	Knowledge sharing among employees	K4
	Data Downloading Frequency from ERP	B2
	User Friendliness of ERP	B1

	Visibility of relevant data throughout the organization Interest in working with ERP	B3
	Interest in working with ERP	K1
Factor 2	Using ERP for operational and managerial requirements	A1
	System audits for quality data	A3
	Trust with the system	A2
	ERP impact on business data handling	A4
	No support software required for data analysis	A5
Factor 3	Visibility to relevant data for collaborative suppliers	C1
	Visibility to relevant data for collaborative service providers	C2
	Customized functions for our internal requirements Use of integrated Information system in the end	C5
	though used multiple ERPs	C3
Factor 4	ERP updating frequency	T4
	Recovery system	T1
	IT external support	T3
Factor 5	Using Same ERP throughout the organization	C4
	Process flow in ERP	B5

As for the hypothesis developed at the beginning of the research paper, the structural model was then confirmed by the multiple regression analysis proving that above identified factors as a set has a significant influence (more than 60%) on ERP usage. Furthermore factor analysis along with the multiple regressions highlighted that another latent variable namely data flow of the ERP had an impact on ERP usage providing below hypothesis model.
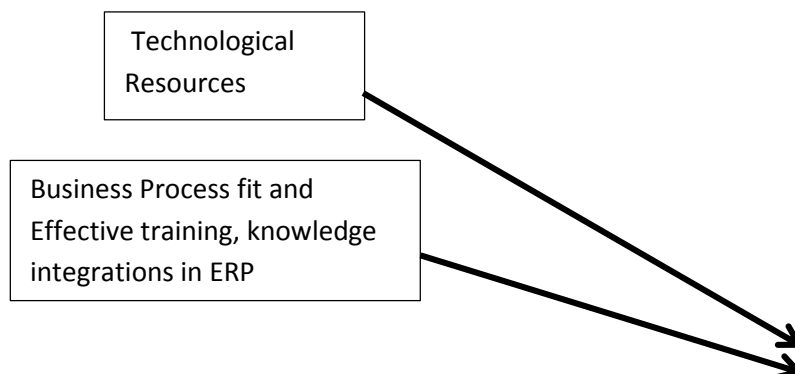
Figure 5.1: Final model developed from the ERP usage data
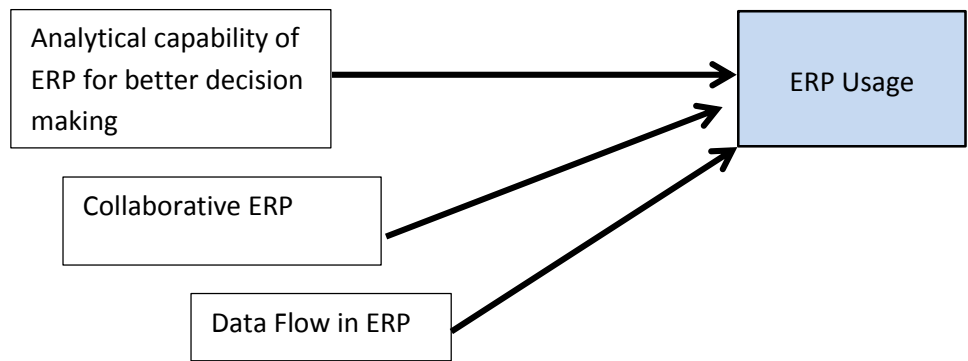
Figure 5.1.2: Final model developed from the ERP usage data

The maturity model aligned with the model used in literature. However, it resulted a much more flat 'S' shaped curve where majority of the organizations lied in middle stage of the curve. But according to sample demographics around 60% of the sample ERP users were using ERP for more than three years which suggested that more of our organizations should have been fallen into stage three in the maturity model if ERP systems are properly used or benefited. Also if the research was carried out with much bigger sample or with cluster sampling we would have seen a more clear maturity model.

6. CONCLUSIONS AND RECOMMENDATIONS

6.1. Introduction

The main objective of this research was to identify the factors that affect to ERP usage in manufacturing organizations and then to identify the influence of ERP maturity in current Sri Lankan manufacturing context. There was a significant relationship

between literature suggested factors as well as a new factor which was identified in the research and ERP usage. Also it should be considered that the results can be subjected to various other factors which were out of the control of the researcher.

The findings of this research can be an influence to companies in which ERP systems are already implemented as well as for those plans adopting ERP in near future as well. The research highlights how to us ERP at its best potential as well as how using an ERP in an effective manner will influence any organization's process. The impact of ERP second wave might not yet identified by the organizations that use ERP still in Sri Lanka but the effect of ERP on organizations procedures especially in supply chain management cannot be considered as a minor aspect.

The maturity model was based on the study conducted by Holland & Ben Light (2014) identifying the stages in ERP model which reveals that majority of the sample fall in to stage two where the organizations are experiencing ERP functionalities and exploring the features and functions. Around 17% of the sample showed characteristics of stage 3 where the organizations have normalized ERP and looking towards best practices, innovative ideas on ERP etc. As a whole maturity model had some similarities with Holland & Ben Lights' model in 2014.

When considering the ERP type distributions in the sample, here too it was evident that the majority was dominated by SAP, Microsoft and Oracle. But significant amount of emerging tier II ERP systems were also prominent. And there were few with multiple ERP systems as well.

6.2. Conclusions

As for the model developed for ERP usage, it was visible that there were several relationships between identified factors and ERP usage. When significance level of greater than 0.05 considered five such latent variables were identified from the collected data, where two of literature suggested latent variables were merged and an additional new variable was highlighted from the study. Each of these relationships has to be evaluated thoroughly in order to get a proper idea regarding the reasons

causing such relationships and to find out the reasons for lower significance levels when it comes to some of the latent constructs.

6.2.1. Business Process fit and Effective training, knowledge integrations to ERP

Business process Fit, Effective training and knowledge integration were two different variables in the initial model designed. However due to some homogeneous characteristics, factor analysis considered both these variables as one.

When it comes to business process fit to ERP it happens to have a significant impact on ERP usage. If the ERP is not generating reports as per business requirement, if the user requires another program to do major amendments in repots downloaded from ERP it will directly impact the user satisfaction level of the system and it's a waste of resources as well. Having an ERP that fits the business process will be a key advantage of having an ERP in the first place eliminating unnecessary delays in the process and having access to real time data.

When training and knowledge integration mechanisms related to ERP is considered it is essential to have a process on training new employees as well as updating them on a regular basis over the changes made in information systems. Also it's important to have a proper knowledge integration procedure in order to have a smooth function in the organization and to avoid knowledge gaps. Both these attributes will lead to a better ERP usage throughout the organization which will result an effective usage of ERP maximizing its contribution towards organization's' functionality.

6.2.2. Analytical capability of ERP for better decision making

Analytical capability and decision making support that an ERP can provide to the organization plays a significant role in modern manufacturing industry. Manufacturing is a fast moving industry; it's needed to have a realistic system which helps the functionality of the organization. Especially majority of these manufacturing organizations are labor incentive and driven by a manufacturing or production plan which requires higher level of decision makings based on forecasts, trends etc. in a

very short lead time which requires an accurate system which the organization can rely in a higher percentage.

Also given the fact that implementation of ERP systems costs lots of initial funding and investments, and if these systems implemented do not full fill the basic requirements of an organization it is a waste of resources again. On the other hand using ERP for analytical requirements will provide accurate data as these ERP systems are made of high level decision making techniques linking to updated information systems.

6.2.3. Collaborative ERP

In the sample data it was evident that the majority of Sri Lankan manufacturing organizations do not use collaborative ERP with their suppliers. Reason for this mainly was trust issues and silo environment that we have inherited from the cultural aspects. But on the other hand there were impressive relationships with third party service providers such as logistic teams and distributors. In a way they are also suppliers so, if these organizations can step out from their traditional point of view about the material suppliers as well and establish collaborative system with them inventory holding costs can be reduced immensely opening doors for better supply chain management.

6.2.4. Technological Resources

Technology plays critical role in now a day's industry. As per ERPs systems are formulated from integrated information systems technological resources are important to ERP systems as well. World trends in these technological aspects tend to move towards artificial intelligence related systems now many organizations thorough out the Globe have adopted these new features and functions in manufacturing field for better service performance. But in Sri Lanka it is evident even in leading manufacturing firms these updated technologies have not being used much not even technologies like bar code scanners in warehousing, cloud computing, RFID are used in majority of manufactures here even today.

6.2.5. Data Flow in ERP

This variable is a new variable identified from the factor analysis. It suggests that there should be prominent data flow throughout the organization eliminating silo data behavior to have a better ERP usage. And also it suggests that using the same ERP throughout the organization has a relationship with better ERP usage. ERP process flow, how ERP data has been updated, how ERP gets integrated throughout the organization departments will be important when addressing ERP usage.

Overall ERP usage can be influenced by all these aspects and for better ERP usage having these factors aligned in the right manner is important. From the research it was evident that more that 66% of the ERP usage relies upon these identified areas and through maintaining better understanding about them and having systems to mitigate issues related to these factors, organizations can have better effective usage of ERP over the investment they made.

6.2.6. ERP Maturity Model

ERP usage or utilization falls as one aspect in ERP maturity model. According to the research model ERP maturity consist of five main factors. Strategic use of IT, ERP Integration on components of value chain, ERP Utilization / benefits, Best practices and Lessons, innovations on ERP were key areas the ERP maturity model focused. According to this study majority of the organizations were in second stage where organizations were adjusting to ERPs new aspects and getting comfortable in using them. But it is required to take a measurement of the time factor too here because majority of these respondents were using ERP for 1 -3 years and its evident that these ERP users have been using ERP for long enough to step towards stage 3 in ERP maturity model where new innovative ideas and lessons needs to be considered.

6.3. Recommendations

When considering recommendations from this study one can say it is evitable for Sri Lankan manufacturing organizations prevent wasting the effort and money on ERP systems through properly maintaining methods and guidelines to monitor ERP usage and maturity through given models and by taking necessary actions to increase the effectiveness of the system. Further it can be recommend that through proper

identification of requirement and using corrective measurements during the designing of ERP systems will always be beneficial in the long run. Hence without implementing ERP systems for the sake of having them it is highly recommended to identify key usage areas and to implement them only to get the cost benefit as well as to minimize unnecessary complexity. As mentioned in the previous segment also lack of collaborative systems and minimum use of latest technology were two main things highlighted in the research given the fact that we considered top players in Sri Lankan manufacturing market. Since reducing lead times and inventory costs are two critical factors in manufacturing industry using ERP systems efficiently will give tremendous opportunities in regards of profit maximization.

6.4. Limitations of the study

The sample size was the main limitation of the study was where only 30 responses were used when analyzing data even though the response rate is considerable. 30 out of 49 is and above average response rate. The respondents had to be forced to get responses which could lead to responses biasness such as demand characteristics bias, extreme response bias and social desirability bias.

This research used LMD business magazine announced top 50 manufacturing organizations as the sample. But to identify the gap in ERP usage and maturity moderate income organizations might be much helpful but the problem is to identify a large sample of them and to approach to them.

The research was based on only very few interviews but more on the questionnaire due to time limitations if able to conduct more interviews with industry experts more focused results might have come to the surface.

6.5. Suggestions and recommendations for future research

This research was an extension of the two main researches identified in literature which was done in Western region. This research relationship suggested that this can be done in different regions of the work can compare the differences and similarities between countries and regions where we can find out different trends and demands in worlds' aspect.

To allow results to be generalized in a larger population, further research should focus on larger samples which will improve validity of the sample.

As identified in the factor analysis latent variables had so many underling variables which could be easily focused on improving usefulness of the research. Factors like why some respondents tend to resist towards change though they were not satisfied with the current system needs to be addressed in a broader scope. Also the study can be focused on different organizational segmentations like finance, marketing, operational and compare and contrast the differentiations among those clusters in ERP usage according to the model.

When considering maturity model, ERP usage/ERP Utilization was only one segment in the maturity model so, further research can be focused deeply in other main four segments in the maturity model as well. Also, this research was only focusing on manufacturing organizations; future researches can be generalized for different organizational segments or on the other hand focus on one particular industry.

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7. APPENDIX

7.1. Appendix II – Data screening

Descriptive Statistics

	N	Std. Deviation
T1	30	.819
T2	30	1.186
T3	30	1.172
T4	30	.999
T5	30	1.075

B1	30	.952
B2	30	.774
B3	30	.961
B4	30	.994
B5	30	.691
K1	30	.928
K2	30	1.073
K3	30	1.095
K4	30	.932
K5	30	1.095
A1	30	.885
A3	30	.834
A4	30	.571
A5	30	1.074
C1	30	1.245
C2	30	1.306
C3	30	1.135
C4	30	.785
C5	30	.850
A2r	30	.932
S1	30	1.295
S2	30	.898
S3	30	.950
I1	30	.944
I2	30	.913
I3	30	.999
U1	30	1.037
U2	30	.913
U3	30	.938
P1	30	1.009
P2	30	1.163
P3	30	1.137
L1	30	.809
L2	30	.777
L3	30	.890
Valid N (listwise)	30	

The Maturity and Usage of ERP in Manufacturing Organizations in Sri Lanka

Dear Sir/ Ma'am,

I am Samuditha Jayasinghe and I am an MBA student attached to the Department of Transport and Logistics, University of Moratuwa. As my final year research project, I am conducting a study on The Maturity and Usage of ERP in Manufacturing Organizations in Sri Lanka. I have prepared a questionnaire in order to gather information for my study and expecting your kind help on this.
The questionnaire will require approximately 10-15 minute of your valuable time and participation is strictly voluntary. All information provided by you will be treated with strict confidentiality and will be used only for academic purposes. The results of this study would be published in academic journals and conferences but it would not reveal the identity of either yours or your organisation.
If you need any further clarifications please be kind to contact me on 0778173562 or email at prarthana.jayasinghe1@gmail.com.

Thanks in advance for your support.

Yours faithfully,
Samuditha Jayasinghe

* Required

1. **Email address** *

   _____

Section 1

This section will focus on general data about your industry type and ERP

2. **1. Select the industry sector of your organization** *
   Mark only one oval.

   ◯ Textile

   ◯ Automobile

   ◯ FMCG

   ◯ Perishables

   ◯ Footwear

   ◯ Other: _____

3. **Select the type of ERP that your organization is using?** *

Check all that apply.

- [ ] SAP
- [ ] Oracle
- [ ] Microsoft
- [ ] IFS
- [ ] Infor
- [ ] Other: _____

4. **3. How long you have been using the ERP?** *

Mark only one oval.

- ( ) Less than 1 year
- ( ) 1 – 3 years
- ( ) 3 – 5 years
- ( ) More than 5 years

5. **4. What is the initial investment on ERP by your organization?**

Mark only one oval.

- ( ) Less than 100,000
- ( ) Between 100, 000 – 500,000
- ( ) Between 500,000 – 20,000,000
- ( ) Between 20,000,000 – 40,000,000
- ( ) More than 40,000,000

6. **5. Do you recommend updating/ changing your organization's ERP?** *

Mark only one oval.

- ( ) No, the one we are having is up to expectations
- ( ) No, do not want to change the procedures
- ( ) No idea
- ( ) Yes, need to modify the system
- ( ) Yes, need to completely change to a new one
- ( ) Other: _____

Section 2

This section will focus on the ERP usage .
Please indicate level of agreement for below statements.

7. **6. Updating/modifying ERP at least once a year will increase the efficiency of ERP.** *

Mark only one oval.

- ⬭ Strongly disagree
- ⬭ Disagree
- ⬭ Neutral
- ⬭ Agree
- ⬭ Strongly agree

8. **7. Our organization is using updated technology such as bar code readers, scanners/RFID and cloud computing etc. in order to feed and maintain data in the ERP.** *

Mark only one oval.

- ⬭ Very Unlikely
- ⬭ Not likely
- ⬭ Neutral
- ⬭ Likely
- ⬭ Very likely

9. **8. Our firm has the IT personnel or support group (ex:3rd party) necessary to support our ERP system.** *

Mark only one oval.

- ⬭ Very Unlikely
- ⬭ Not likely
- ⬭ Neutral
- ⬭ Likely
- ⬭ Very likely

10. **9. Our system maintains a business continuity plan in order to recover in case of ERP failure.**
*

Mark only one oval.

- ⬭ Very Unlikely
- ⬭ Not likely
- ⬭ Neutral
- ⬭ Likely
- ⬭ Very likely

11. **10. Our firm's IT team has the ability/knowledge to enhance the current ERP into specific customized versions/transactions.** *

Mark only one oval.

- ◯ Strongly Disagree
- ◯ Disagree
- ◯ Neither Agree or Disagree
- ◯ Agree
- ◯ Strongly Agree

12. **11. Our ERP is user friendly and easy to understand** *

Mark only one oval.

- ◯ Strongly Disagree
- ◯ Disagree
- ◯ Neither Agree or Disagree
- ◯ Agree
- ◯ Strongly Agree

13. **12. On a regular basis we download data from our ERP** *

Mark only one oval.

- ◯ Strongly disagree
- ◯ Disagree
- ◯ Neutral
- ◯ Agree
- ◯ Strongly agree

14. **13. Features and functions of ERP like production plan, visible to operational departments within our organization and they are well aware of extracting data from ERP.** *

Mark only one oval.

- ◯ Very Unlikely
- ◯ Not likely
- ◯ Neutral
- ◯ Likely
- ◯ Very likely

15. **14. The format of reports downloaded from ERP corresponds to the documents used in the company so that manual adjustments/manual checking is minimized.** *

Mark only one oval.

- ◯ Very Unlikely
- ◯ Not likely
- ◯ Neutral
- ◯ Likely
- ◯ Very likely

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16. **15. The process flow built in ERP helps to integrate components within the organization and eliminate silo environment. ***

Mark only one oval.

- ⬭ Strongly disagree
- ⬭ Disagree
- ⬭ Neutral
- ⬭ Agree
- ⬭ Strongly agree

17. **16. Our employees are very enthusiastic about using the ERP in our organization. ***

Mark only one oval.

- ⬭ Strongly disagree
- ⬭ Disagree
- ⬭ Neutral
- ⬭ Agree
- ⬭ Strongly agree

18. **17. Our organization often provides us effective training programs which will enhance knowledge on ERP usage and recent upgrades made on ERP. ***

Mark only one oval.

- ⬭ Strongly Disagree
- ⬭ Disagree
- ⬭ Neither Agree or Disagree
- ⬭ Agree
- ⬭ Strongly Agree

19. **18. Our employee turnover could be influenced by the difficulty in ERP usage. ***

Mark only one oval.

- ⬭ Very Unlikely
- ⬭ Not likely
- ⬭ Neutral
- ⬭ Likely
- ⬭ Very likely

20. **19. Within our functional teams ERP knowledge sharing happens more frequently and it is a job role requirement to share ERP knowledge on replacement. ***

Mark only one oval.

- ⬭ Strongly disagree
- ⬭ Disagree
- ⬭ Neutral
- ⬭ Agree
- ⬭ Strongly agree

21. **20. For ERP modifications we actively involve employee ideas, requirements all the time and encourage them on innovative ideas which improve efficiency of the ERP system on business process.** *

Mark only one oval.

- ( ) Strongly Disagree
- ( ) Disagree
- ( ) Neither Agree or Disagree
- ( ) Agree
- ( ) Strongly Agree

22. **21. We directly download reports from our ERP system for daily operational requirements as well as for managerial decision making purposes .** *

Mark only one oval.

- ( ) Strongly Disagree
- ( ) Disagree
- ( ) Neither Agree or Disagree
- ( ) Agree
- ( ) Strongly Agree

23. **22. We often check manually the data downloaded from the system because we don't trust the system.** *

Mark only one oval.

- ( ) Very Unlikely
- ( ) Not likely
- ( ) Neutral
- ( ) Likely
- ( ) Very likely

24. **23. We carryout system data audits in regular intervals to make sure the data in the system accurate, reliable and relevant.** *

Mark only one oval.

- ( ) Strongly Disagree
- ( ) Disagree
- ( ) Neither Agree or Disagree
- ( ) Agree
- ( ) Strongly Agree

58

25. **24. ERP has a serious positive impact on organization's data handling procedure resulting better business performance.** *

Mark only one oval.

- ⬭ Strongly disagree
- ⬭ Disagree
- ⬭ Neutral
- ⬭ Agree
- ⬭ Strongly agree

26. **25. Always we use our very own ERP system to analyze data without using another program or 3rd party service provider.** *

Mark only one oval.

- ⬭ Very Unlikely
- ⬭ Not likely
- ⬭ Neutral
- ⬭ Likely
- ⬭ Very likely

27. **26. We use collaborative ERP with suppliers where their relevant ERP data is visible to us and vice versa.** *

Mark only one oval.

- ⬭ Very Unlikely
- ⬭ Not likely
- ⬭ Neutral
- ⬭ Likely
- ⬭ Very likely

28. **27. We use collaborative ERP with 3rd party service providers like logistic teams, where their relevant ERP data is visible to us and vice versa.** *

Mark only one oval.

- ⬭ Very Unlikely
- ⬭ Not likely
- ⬭ Neutral
- ⬭ Likely
- ⬭ Very likely

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29. **28. We use multiple ERP systems but each of them is linked to each other making a collaborative integrated system together.** *

Mark only one oval.

- ◯ Very Unlikely
- ◯ Not likely
- ◯ Neutral
- ◯ Likely
- ◯ Very likely

30. **29. We use different functions but same ERP system/s in all departments of the organization.** *

Mark only one oval.

- ◯ Very Unlikely
- ◯ Not likely
- ◯ Neutral
- ◯ Likely
- ◯ Very likely

31. **30. Our ERP has customized transactions/functions which are designed specifically for our functional requirements.** *

Mark only one oval.

- ◯ Very Unlikely
- ◯ Not likely
- ◯ Neutral
- ◯ Likely
- ◯ Very likely

32. **31. My overall satisfaction of our organization's usage of ERP's full potential is;**

Mark only one oval.

- ◯ Very unsatisfied
- ◯ Unsatisfied
- ◯ Neither satisfied or dissatisfied
- ◯ Somewhat Satisfied
- ◯ Very Satisfied

Section 3

This will focus on the maturity of your ERP.
Please rate in the scale of 1 - 5 on your organizations' aspect of your ERP

60

33. **Where 1 is not important and 5 is very important to your organization.** *
Mark only one oval per row.

	1	2	3	4	5
32. IT team identifying the core requirements of ERP and always providing the best IT solution	◯	◯	◯	◯	◯
33. Management commitment and representation in strategic decisions regarding ERP	◯	◯	◯	◯	◯
34. Having a knowledgeable IT team to design and build ERP requirements up to date	◯	◯	◯	◯	◯
35. ERP data getting integrated from different departments in order to get a final result or outcome eliminating silo behavior	◯	◯	◯	◯	◯
36. ERP used for day to day functional requirements as well as higher-level decision making	◯	◯	◯	◯	◯
37. ERP aligning with the process of organization resulting least manual work	◯	◯	◯	◯	◯
38. Frequency of ERP data usage per week	◯	◯	◯	◯	◯
39. ERP has a positive impact on business operation performance	◯	◯	◯	◯	◯
40. Overall ERP usage and the idea of ERP among the employers	◯	◯	◯	◯	◯
41. Maintaining a business continuity plan	◯	◯	◯	◯	◯
42. Regular system audits to improve the data quality	◯	◯	◯	◯	◯
43. Having real time data visibility to all the employees within the organization	◯	◯	◯	◯	◯
44. Investments on continuous improvement of ERP	◯	◯	◯	◯	◯
45. Frequency of ERP system modifications according to the requirements of employees	◯	◯	◯	◯	◯
46. Having a feedback system and tracking system for data change or update	◯	◯	◯	◯	◯

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