Priortizing Enterprise Resource Planning (ERP) Systems for Small and Medium Enterprises

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Abstract— Enterprise Resource Planning (ERP) are enterprise-wide systems that automate all of a company's business processes enable to share information and communication. Although there are lots of benefits of ERP, the construction industry is far behind the ERP implementation. There are so many reasons for this low-level adaptation. The objective of this research is to give guidance to medium size enterprises for a successful implementation via complexity index built upon four basic parameters Product, People, Project and Business processes. A critical literature review was carried out to identify the key contributing factors for successful implementation. Subsequently a questionnaire survey and semi-structured interviews were carried out with selected ERP consultants, users, and employees. The findings revealed that key contributing factors for successful ERP systems are Product, People, Project, and Company business processes dimensions. Further, it is concluded that there is a strong positive correlation between these variables. Development of Complexity Index was carried out by using the ERPs in the current industry, and they are ranked according to the "Panorama ranking reports-2017". Complexity analysis revealed that for small to medium size enterprises (SMEs) it is better to use low ranking ERPs rather than high-ranking ERPs.

Keywords— Enterprise Resource Planning, Medium scale Business, People, Product, Business process, Project, Complexity Index

I. Introduction

Many organizations find ways to improve their business performance and continuously re-adjust and re-align their business operations to meet the company goals. They are using several software to achieve this target. Enterprise resource planning (ERP) systems are one of the major software which can manage, integrate and drive business functions more efficiently and smoothly [1]. Thus, lot of large entities in the world are moving towards the implementation of ERP for their business operations [2, 3]. Similarly, in Sri-Lanka ERP has been adopted by most of the large companies but not by small and medium sized companies (SME's).

Though lots of SME's are not willing to accept the system, due to the satuaration of ERP in large companies, most of the ERP vendors are moving towards them [2]. Because of this, there are plenty of ERP systems available in the market for SME's. And also, at the current situation medium-sized companies have reveal that they need integrated systems for their operations when the capacity of the individual systems is no more enough for them [4].

There can be many reasons for SME's not to adopt information systems for their operations [5]. But with the enhancement of the complex operations in their entities, the requirement of integrated system is getting mandatory. On the other hand, as SME's are the backbone of the economies of most of developing countries, the huge investment on ERP should not be a waste for them [3]. Due to their limited resources, SME's might have greater difficulties in overcoming an ERP implementation failure compared to large organizations. Therefore, they need a proper guidance to select a required type of ERP systems for the organization [6]. This research will provide the guidance for them to select the compatible ERP type for their organizations.

II. Litraure review

Several studies have investigated various factors effecting for ERP implementation in SME's as per the TABLE 1. Most of the researchers have identified several barriers for ERP adoption and few have addressed the solution to overcome the problem. Through this research, it is expected to introduce a complexity index thus organization can identify compatible ERP type for their organization. Using that, companies will prevent unsuccessful failures of ERP and will save huge investment.

TABLE I.   SUMMARY OF PREVIOUS LITERATURE

Factors Identified	Publication
Limited resources, Limited IS knowledge, Lack of IT expertise, Wrong IT investment decisions, Low CEO support	[9, 21]
Complex implementation process, High resource requirement, Traditional policies and practices	[19]
Organizational factors, People factor, Uncertainty factors	[23]
Organizational issues, Technological issues, and Environmental issues.	[24, 25]
Organizational issues, Technological issues, Business Size, Industry type	[23]
Incompatibility of Processes and procedures, ERP type	[26]
Project management principles, Evaluation of ERP projects, Human resource development, Process re-engineering, Top management support, cost/Budget, IT infrastructure, Consulting services	[8]
Organizational barriers (Lack of human resources), Technological barriers (Unbalanced combination of team projects), Individual barriers (Lack of senior involvement)	[4]

Though the concept of ERP implementation based on installation of hardware and software usually, according to above analysis it is clearly indicate that implementation is not about technical components itself. Therefore, after summarizing the above past researches the factors were selected as "Product itself", "People-the End users", "Projects which use ERP" and "Business processes related to ERP implementation" to develop the complexity index.

Product:
When companies consider buying a new product, the perceived characteristics of the product play an important role in the final decision to start using that new product. Not surprisingly Supplier cooperate image, Market price, Technology, and Compatibility with sub components are major [13]. In addition, mid-market enterprises are concerned about User friendliness, Usability, Size and the Installation ability [13]. Further functionality was selected as a most important selection criteria Along with that functional requirements are also polled out by the customers [5, 10].

People:
User resistance can be considered as a paramount factor in implementing ERP system. After implementing an ERP system there will be many social problems which make user resistance more significant. The User resistance may lead to over budget spending, delays in project or underutilization of resources [11, 14]. Thus, it is very necessary to focus on User resistance before implementing an ERP system. It can be properly handled by having active involvement from the employees in the selection process (e.g. User Comments, User

Inquiries, Communication), giving good training (e.g. Development of User Skills), better assistance on adopting (e.g. Team Complexity) and extending the changes slowly [7, 27].

Project:
The company which is going to implement ERP system should have an expert knowledge about the project which they are going to apply the system. The project management practices, training and education and legacy systems had significant impact on the implementation. The success of the ERP mainly depends on the objectives and the goals of the company. ERP vendors should identify the extent of customization and the quality, resource capacities, time required on each project according to the goal of the client organization [4].

Business Processes:
A business process is a collection of activities that takes one or more kinds of inputs and creates an output that values to the customer [16]. ERP helps to manage companywide business processes using common database and shared management reporting tool [4]. But the main things are business processes should be aligned, integrated, adapted, updated and accurate with the ERP procedures [12]. Unfortunately, many ERP systems do not provide tight-fitting software for specific business processes particularly for small and unique business processes. Thus, setting up the standards on ERP as well as business is a must to have a successful ERP implementation.
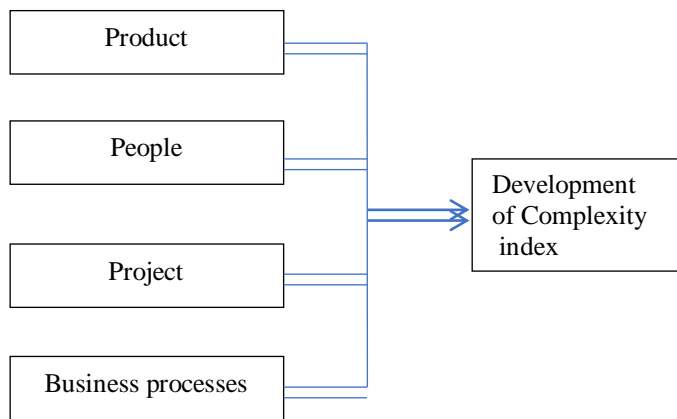
Fig. 1: Components of complexity index

III. Methodology

The principal method used to collect information for this study was the questionnaire survey and it was built according to the variables identified through the literature review, discussions with consultants, experts and the users. Four main variables were defined after summarizing the previous studies based on

ERP implementations in SME's as shown in Fig.1. The sample was selected from medium-sized companies listed in stock exchange in Sri-Lanka (300). For the sample size confidence interval was considered as 95% with Z=1.96, Standard deviation +-0.5, Marginal error 5%. The sample size is considered adequate for the analysis and is comparable to response rate for ERP systems available in mid-sized organizations in Sri-Lanka. Sample size was calculated from the below equation (1) which was developed by Cochran [28]. Further, the characteristics of the sample are described in TABLE II according to the Industry, Education and Experience.

$$Sample\ Size = \frac{\left[\frac{[Z2 \times p \times (1-p)]}{e2}\right]}{1 + (\frac{[Z2 \times p \times (1-p)]}{e2N}}$$

Population Size=N
Margin of error =e
Z-Score=Z
Sample size (210) > Required size (169)

TABLE II.   Characterisitics of the Sample Selected for Questionnaire Survey

Criteria		Frequency	Percentage (%)
Industry Distribution	Manufacturing	104	49.5
	Service	74	35.2
	Retail	28	13.2
	Other	4	2.2
Educational Distribution	Postgraduate Degree	39	18.7
	Bachelor's Degree	67	31.9
	Diploma	46	22.0
	Certificate	39	18.7
	Other	18	8.8
ERP experience (Years)	2>=E>=0	83	36
	5>=E>2	103	45
	10>=E>5	21	9
	15>=E>10	2	1
Total Sample		210	100

When analyzing the data, ERP used in these companies were ranked from 1 to 7 according to the "Panorama ranking reports -2017'. This ranking system used five main criteria namely market share, time to implement, cost to implement, time to realize and benefits to industry to rank the ERPs. When developing the complexity index, questionnaire was rated according to a Likert scale ranges from 1 to 5. A scale is a tool or a mechanism which individuals are distinguished as to how

they differ from another variable of the study [15]. The lowest digit represents the less impact on complexity and highest digit represents the high impact on complexity. ERP complexity index was calculated using SPSS version 16.0 and Microsoft Excel where appropriate.

IV   RESEARCH FINDING AND DISCUSSION

A. *Identification of key factors for successful ERP implementation*

As per the literature review it is identified that success of the ERP system mainly depends on four criterions namely Product, People, Project and Business processes. But Munir Ahmad and Ruben have identified sixteen critical success factors (CSF's) for the implementation of ERP in SME's and they have concluded that further researches are required to identify the relationship between each variable. According to this research those sixteen CSF's can be put under above four criterions and the gap of identifying the relationship of the variable are fulfilled. The correlation analysis among independent variables Product, People, Project and Business processes shows a significant positive interrelationship among each other. The highest correlation 0.587 shows between "Project and People". Then," People and Product (0.574)"," Project and Product (0.553)"," People and Business process (0.516)"," Product and Business Process (0.385)" and" Project and Business Process (0.360)" respectively shows the correlation between each variable. Therefore, it is clear that SMEs need to consider the capacity of their entity to fulfill above for requirements before implementing the ERP. The output-correlations among parameters are shown in TABLE III.

TABLE III.   CORRELATION AMONG INDEPENDENT VARIABLES

	ProductD	PeopleF	ProjectD	BusP
ProductD	1	0. 574	0. 553	0. 385
PeopleF	0. 574	1	0. 587	0. 516
ProjectD	0. 553	0. 587	1	0. 360
BusinessP	0. 385	0. 516	0. 36	1

Correlation is significant at the level 0. 01 level (2-tailed)

B. *Establishment of complexity index for the selection of ERP system*

ERP systems in the current ERP market (Sri-Lanka) are rated from 1 to 7 according to the Panorama report-2017. In this analysis mean value represents the complexity of the ERP systems. The mean value closer to 0 denotes higher complexity while mean value closer to 5 denotes lesser complexity. TABLE IV,V,VI,VII show how the complexity of ERP system deviate accoridng to the Product, People, Project and Business processes respectively. And TABLE VIII and TABLE IX show how each factor contribute to built up the overall complex index.

TABLE IV.   COMPLEXITY ANALYSIS OF ERP BASED ON PRODUCT DIMENSION

Name of the ERP	Mean	Std Deviation	ERP complexity factor
ERP2	3. 335	0. 349	7
ERP1	3. 462	0. 339	6
ERP3	3. 555	0. 276	5
Other	3. 606	0. 292	4
ERP5	3. 62	0. 185	3
ERP6	3. 833	0. 327	2
ERP4	3. 977	0. 271	1

TABLE V.   COMPLEXITY ANALYSIS OF ERP BASED ON PEOPLE FACTOR

Name of the ERP	Mean	Std Deviation	ERP complexity factor
ERP1	3. 105	0. 385	7
ERP3	3. 246	0. 191	6
ERP5	3. 251	0. 542	5
Other	3. 308	0. 353	4
ERP2	3. 346	0. 267	3
ERP6	3. 744	0. 226	2
ERP4	3. 98	0. 29	1

TABLE VI.   COMPLEXITY ANALYSIS OF ERP BASED ON PROJECT VIEW

Name of the ERP	Mean	Std Deviation	ERP complexity factor
ERP3	2. 992	0. 329	7
Other	3. 205	0. 194	6
ERP5	3. 217	0. 268	5
ERP1	3. 246	0. 285	4
ERP2	3. 333	0. 283	3
ERP4	3. 512	0. 302	2
ERP6	3. 782	0. 259	1

TABLE VII.   COMPLEXITY ANALYSIS OF ERP BASED ON BUSINESS PROCESS

Name of the ERP	Mean	Std Deviation	ERP complexity factor
ERP1	3. 163	0. 47	7
Other	3. 25	0. 866	6
ERP3	3. 35	0. 337	5
ERP5	3. 477	0. 617	4
ERP6	3. 667	0. 342	3
ERP2	4. 000	0. 302	2
ERP4	4. 322	0. 281	1

TABLE VIII.   Overall Complexity Analysis according to the Criteria

Dimension	ERP1	ERP2	ERP3	ERP4	ERP5	ERP6	Other
Product	6	7	5	1	3	2	4
People	7	3	6	1	5	2	4
Project	4	3	7	2	5	1	6
Business Process	7	2	5	1	4	3	2
Overall Rank	7	3	6	1	4	2	5

TABLE IX.   Complexity Index for the ERP's in the Market

Name of the ERP	Mean	Std Deviation	ERP complexity Index
ERP1	3. 28	0. 32	7
ERP3	3. 29	0. 15	6
Other	3. 34	0. 30	5
ERP5	3. 35	0. 31	4
ERP2	3. 51	0. 20	3
ERP6	3. 76	0. 23	2
ERP4	4. 01	0. 23	1

Based on the above results, overall complex index was developed for the ERP systems. TABLE VIII shows how the ERP systems behave according to the selected Product, People, Project and Business Process criterions. Then, TABLE IX shows the overall mean value of each ERP systems according to their complexity.

Ahmad and Cuenca have investigated that most of the SME fail in the ERP implementation because of investing large amountof money on the high end ERP systems [29,30,31]. According to the above analysis also it is verified that higher end ERP systems have higher complexity index comparatively to other ERP types. Findings show that ERP1, ERP3 records higher complexity index with the mean value of 3.28 and 3.29 (According to the Likert scale) with standard deviations of 0.32, 0.15. Thus, it is clear that high ranked ERP systems consist with complex solutions and they are more suitable for large organizations. ERP's like ERP2, ERP5 shows medium complexity according to the data analysis. According to the output, ERP4 shows lowest complexity index with the mean value of 4.01 and standard deviation of 0.23. The significant output obtained from this analysis is the low complexity index shown by open source ERP type ERP6. Open source ERP shows a lesser complexity index as it needs lower proprietary technologies, hardware, and software. And also it doesn't require license cost of third-party components like operating systems and databases. Low complexity value of ERP6 (Open source ERP) provides a positive demarcation and recommendation for small & medium scaled businesses in the ERP market.

When analyzing further it is clearly identified that open source ERP systems would never compatible with large business operations in large companies. But for SME's that would be the best ERP solution so far. This observation has been verified by the research surveying done by Hyoseob Kim and Cornelia Boldyreff with open source ERP packages available in open source repositories. In their survey, almost all the ERP's used were geared towards the SME's market. This certifies the compatibility of open source ERP systems in SME market [23,32].

Therefore, it is recommended that low complexity indexed, low ranked ERP system are more suitable for small and medium sized companies than high complexity indexed ERP systems. Beyond that open source ERP systems will be more align with SME operations and will allow them to get the maximum befit out of ERP systems.

IV.   Conclusion

According to the objectives of the research four main criterions which effect for the ERP implementation in SME's were identified as Product, People, Project and Business Process through the previous researches carried out. And it is established that there is a strong possitive correlation with each factor identified. It emphathyse that if one variable is missed there will be a significant impact on ERP implementation of the organization.

The other objective of the research was to find out the best ERP type for SME's. Through the research it is concluded that use of cloud ERP system (ERP6) will be the best selection with complexity mean value 3.76. That is because low ranking ERP systems are manageable by SME's rather than high ranking ERP systems.

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