



OPEN SOURCE ERP SYSTEMS SELECTION MODEL:

CASE OF SMALL AND MEDIUM ENTERPRISES IN BOTSWANA

By

BADIREDI SEOKE

Reg. No: 14100248

BSc (Business Information Technology) (University of Greenwich)

Department of Computer Science and Information Systems,

College of Science

Botswana International University of Science and Technology

badiredi.seoke@studentmail.biust.ac.bw, (+267) 73358612/ 74141242

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Supervisor: PROF. IRINA ZLOTNIKOVA

Department of Computer Science and Information Systems,

College of Science, BIUST

zlotnikova@biust.ac.bw, (+267) 4900117

Signature *Badiredi Seoke* Date: 28.08.18

28 August 2018

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I, Badiredi Seoke, declare that this dissertation is my own original work and that it has not been presented and will not be presented to any other university for a similar or any other degree award.

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CERTIFICATION

The undersigned certifies that he has read and hereby recommends for acceptance by the College of Science a dissertation titled: **OPEN SOURCE ERP SYSTEMS SELECTION MODEL_CASE OF SMALL AND MEDIUM ENTERPRISES IN BOTSWANA** in fulfilment of the requirements for the degree of Master of Science (Information Systems) of the BIUST.

.....*30/08/18*.....

Prof.

(Supervisor)

Date:*28.08.18*.....

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LIST OF ABBREVIATIONS

ERP	Enterprise Resource Planning
SMEs	Small and Medium Enterprises
CEDA	Citizen Entrepreneurial Development Agency
ICT	Information and Communication Technologies
IS	Information Systems
IT	Information Technology
CRM	Customer Relations Management
BPM	Business Process Management
CSF	Critical Success Factors
OSS	Open Source Software
GNU	General Public License
MPL	Mozilla Public License
OBPL	Open Bravo Public License
PIRCS	Prepare Identify Rate Compare Select
MRP	Manufacturing Resource Planning
RFI	Request for Information
RFPs	Requests for Proposals
LEA	Local Enterprise Authority
BPR	Business Process Re-Engineering Reengineering
AHP	Analytic Hierarchy Process
LMS	Learning Management System

ABSTRACT

Enterprise Resource Planning (ERP) systems are one of the technologies that many organisations, including Small and Medium Enterprises (SMEs), have adopted. However, most of commercial ERP packages are designed for large-scaled companies. More complex nature of business processes in large companies makes it difficult for SMEs to adopt commercial ERP packages. The high costs of ERP system implementation mean that SMEs need to seek for alternative solutions which are less expensive. One of these solutions is the Open Source ERP systems. The availability of Open Source ERP software and tools has not changed the uptake of ERP by SMEs. The above problems call for the development of a model which can be used by SMEs, to select Open Source ERP systems which will exactly match the business processes in SMEs.

The general objective of this study was to develop a model that could guide the selection of Open Source ERP Systems by SMEs. Open Source ERP systems Selection Model was developed and used in evaluating common Open Source ERP Systems available in the market. The model consists of four components which include: (a) the evaluation criteria for selecting an Open Source ERP system, (b) factors related to the adopting organisation, (c) Open Source ERP system quality characteristics and (d) critical success factors for ERP systems implementation. The first objective which was to identify the components of Open Source ERP System Selection Model and these was achieved by the use of questionnaires. These components present the evaluation criteria which were used to evaluate the Open Source ERP Systems. The second specific objective was to evaluate existing Open Source ERP systems using the proposed model and provide their ranking. An evaluation was performed on ten Open Source ERP systems. Those Open Source ERP systems were then ranked according to the score they attained. From the evaluation, three best Open Source ERP systems were identified and introduced to few selected SMEs. The third objective of this study was to validate the Open Source ERP systems Selection Model. This objective was achieved through the survey in the SMEs where the three Open Source ERP systems were introduced. The balanced scorecard method was adopted for the measurement of the user satisfaction and ERP performance of the three systems.

This study provides Open Source ERP systems Selection Model which guides the selection of the Open Source ERP systems. This study contributes to the current awareness and adoption of the Open Source ERP systems by SMEs, and this will lead to increase in the uptake of ERP by SMEs.

CHAPTER ONE: INTRODUCTION

1.1 Introduction to the Problem

Economic diversification is a key policy for the Government of Botswana [2]. One area specified in this the policy is the improvement of the performance of the Small and Medium Enterprises (SMEs). The definition of SME in Botswana is given by the Ministry of Commerce and Industry and states that a small enterprise is an enterprise which employs less than 25 employees and has an annual turnover of between P60,000.00 and P1,500,000.00. A medium enterprise is that which employs less than 100 employees and has an annual turnover of between P1,500,000.00 and P5,000,000.00 [1].

SMEs play an important role in achieving economic development of any country [2]. SMEs are a significant component of many national economies because they contribute to employment creation and facilitate regional developments and innovations. In Botswana the SME sector employs 32% of the workforce, thus contributing significantly to the economic development objectives [3]. The Botswana government in 2000 established a Citizen Entrepreneurial Development Agency (CEDA) which mandate is to provide funding for the development of competitive and sustainable citizen owned businesses, as well as joint ventures and this business includes SMEs. However, as SMEs continue contributing to the economy, they are faced with challenges which hinder them to compete with large enterprises. One of the major limitations is the lower level of adoption of Information and Communications Technologies (ICTs) by SMEs, as compared to large enterprises. The Government of Botswana fully understands and appreciates the developmental importance of ICTs, specifically in SME sector. However, SMEs are less likely to have a robust IT team, as well as the IT infrastructure consequently this prevents them from adopting the ICTs.

Adoption of ICT by SMEs changes the business operations by enabling rapid, reliable and efficient exchange of information [4]. ICT play a vital role in creating a SME's competitive advantage. ICT provide potential benefits to SMEs which include, but not limited to: (a) cost reduction leading to more revenues, (b) improved performance and efficiency and (c) faster communication with customers and suppliers. Usage of ICT in business companies is considered a strategic tool, as it can streamline business operations, improve information flow across functions, improve business flexibility and integrate disparate functionalities [4].

Enterprise Resource Planning (ERP) systems are one of the technologies that many organisations, including SMEs, have adopted [4]. The idea behind ERP is that it communicates across business functions and permits efficient exchange of relevant data regarding all processes with the organisation [5]. ERP normally incorporates key business functions, such as order processing, inventory management, human resource management, production control, sales and marketing and finance. An Enterprise Resource Planning system integrates all necessary business functions into a single system with a shared database [4]. ERP systems enable SMEs to replace different departmental information systems and databases with one system with components that work together and utilize a single database. Like many other technological advances, ERP systems were originally implemented mostly at large organisations, nevertheless, now SMEs are also adopting ERP systems. Adoption of ERP systems by SMEs improves the interaction between the business functions, and the information is more reachable to the decision makers due to efficiency in information processing [4], [6]. The use of ERP systems improves and standardises processes and allows monitoring [6].

Other benefits of adopting ERP systems include: (a) replacement of inefficient standalone systems, (b) reduction of errors, (c) reduction in cost of operation, (d) improved customer relations and (e) better communication between businesses[7].

Despite the efforts made by the software engineering community, failure of software projects keep increasing at an alarming rate [8], [9]. These include failures of ERP systems [8].

Statistics suggests that 60 % to 70% of ERP projects fail [10], [11]. The common problem of the existing ERP systems is misfits of the ERP packages [12], [13]. ERP projects fail due to misfits between the adopting organization's business requirements and the ERP system functionalities [13]. Existing literature has studied how ERP systems match to different organizations and have argued that there always exists a gap in terms of the data, functionality and output between the business rules embedded in the system and the practices and processes that exist in organizations [12], [13], [14]. ERP systems misfits occur when the new technologies capabilities and needs are mismatched with the organizations existing business processes and procedures [14]. A successful ERP system implementation requires that the ERP system fully fits in the organisational business processes [13].

An ERP system is known for its high implementation cost [15]. Cost of ERP implementation includes cost of customization, integration, data conversion, data migration, testing and training and some hidden costs [10], [12], [15]. Organisations have been progressively

adopting and using ERP systems investing millions of dollars throughout the world [16], [14]. The high cost of ERP system implementation means that SMEs need to seek for an alternative approach which is less expensive. Open Source Software (OSS) gives the same functionalities as commercial one but at a cheaper cost, yet the SMEs are not taking advantage of this software [17]. The Open Source ERP systems offer a cost effective alternative to SMEs. Despite the availability of Open Source ERP tools, this has not significantly increased the uptake of ERP by SMEs [17]. However, the SMEs barriers to entry for ERP systems have come down in recently with the advent of cloud-based services [18]. Open Source and cloud based systems have the potential to make ERP systems affordable and available to wider group of businesses [18]. Although licensing for Open Source ERP systems is free, a locally installed Open Source ERP system would require in-house experts for installation, maintenance, data migration, upgrades and user training. For this reason SMEs considerations for implementing Open Source ERP systems are likely to opt for cloud-based services [18]. Open Source ERP systems can be considered as a more reasonable alternative for SMEs than commercial ERP systems. An Open Source ERP system can easily be customised, thus addressing the challenge of misfit of the system with the business processes of the SMEs. For the Open Source ERP systems it is possible to access the source code that for commercial systems belonging to the vendor [19].

Due to the benefits brought by Cloud Computing services, these had motivated the SMEs to use Open Source [19]. Cloud Computing offers a solution for SMEs to access and adopt these new technologies. Cloud Computing has the potential to play a key role in addressing inefficiencies and make an important contribution to the growth and competitiveness of enterprises mainly for SMEs [20]. By adopting Cloud Computing services SMEs will be able to obtain the latest technology, without the need for an upfront cost [21]. Cloud Computing enhances the adoption of the Open Source ERP system because it reduces the cost of implementing business software including Open Source ERP systems. SMEs willing to adopt Open Source ERP systems are highly interested in cloud services, as it assists them to lower the cost, and to enhance the flexibility and scalability [20]. Hosting Open Source ERP systems on the cloud enables SMEs to reduce their expenditure on software and hardware [20]. Cloud Computing reduces business costs at the front for the servers of the enterprise. The extra costs associated with increasing memory, hard drive space and processing power are all abolished. Another key benefit of cloud services is the centralized data. The information from different branches is stored in one location that can be accessed from

remote places and this enhances sharing capabilities. Cloud Computing providers enable automatic data backup on the cloud system and offer better security to the business information [20].

1.2 Problem Statement

Most of commercial ERP packages are designed for a large-scaled company. More complex nature of business processes in large companies makes it difficult for SMEs to adopt these packages as they are [8], [22]. The current challenge facing SMEs is the escalating cost of an ERP system implementation [23]. Even though the ERP software vendors have customized smaller versions of ERP for SMEs, the cost of implementation is still high [23]. Most SMEs are not able to develop adequate definitions of functional requirements. SMEs management responsible for ERP system selection usually lead the implementation based on opinions and views from their prior experiences without identifying new functional requirements based on the current environment. Sometimes, these executives involved in the selection of the ERP system are not computer literate, that is to say they do not know much about ERP systems characteristics offered to them and whether they, meet the SMEs requirements [12]. In spite of the benefits offered by adopting ERP systems, SMEs often make wrong decision in selecting and evaluating ERP systems, thus ending up with a problem of misfits between ERP systems and the SMEs business processes. Most research undertaken with regard to ERP systems and Open Source Software (OSS) has been for developed economies [24]. In developing countries neighbouring Botswana the literature had found that lack of awareness, and less knowledge on Open Source ERP systems, the lack of sufficient providers (or vendors), and high implementation costs, are the adoption barriers to Open Source ERP systems [24]. In African countries like South Africa and Morocco the following Open Source ERP system are used: Compiere, OpenBravo, OpenERP, Adempiere, Odoo, XTuple and Opentaps [24], [25]. Technology-Organization-Environment (TOE), Technology Acceptance Model (TAM), and Social Identification Theory (SIT) were used to evaluate and select those Open Source ERP systems [24]. Despite the reputation of these models, there is a lack of appropriate relevant constructs and evaluation criteria which could be used specifically for selecting Open Source ERP systems. The above problem calls for a development of a model which can be used by SMEs to select Open Source ERP systems. The proposed model addresses the current challenge of escalating cost of an ERP system implementation facing SMEs.

1.3 General and Specific Objectives

The general objective of the study is to develop a model that can guide the selection of Open Source ERP systems by SMEs.

The **specific objectives** of this research are as follows:

- To determine the components of the Open Source ERP Systems Selection Model.
- To evaluate existing Open Source ERP systems using the proposed model and provide their rankings.
- To validate the Open Source ERP Systems Selection Model

1.4 Research Questions

To achieve the objectives stated above, the following research questions have been set:

- What are the components of the Open Source ERP Systems Selection Model?
- What criteria can be used to select Open Source ERP systems for SMEs in Botswana?
- What are the available and best fit Open Source ERP systems for SMEs in Botswana?
- How can the Open Source ERP Systems Selection Model be validated?

1.5 Significance of the Study

The SME sector plays a significant role in developing economies like Botswana. This research work contributes to the body of knowledge by presenting Open Source ERP systems Selection Model, which can be used by SMEs when selecting Open Source ERP systems. The research work would encourage SMEs to adopt Open Source ERP systems, as it outlines barriers to adoption of Open Source ERP systems by Botswana SMEs and identifies the ways in which ERP systems can improve the performance of SMEs. This study also revealed the recommendations for Open Source ERP systems which could meet the requirements of for SMEs. This research is of importance to the SMEs owners and employees willing to adopt or select Open Source ERP systems.

This study contributes to the research stream on contextual influences of Open Source ERP system adoption and selection, with particular focus of the Botswana SMEs. The study also contributed to the knowledge domain of Open Source ERP systems by exploring the areas that lack sufficient research within the ERP in SMEs selection domain, which included in

cooperating the software quality characteristics and Critical Success Factors for ERP selection. The model developed in this study identifies the components that may be integrated in the selection and evaluation of Open Source ERP systems. The findings of this study indicate that SMEs should improve their strategic planning of IS utilization in the context of selecting and evaluating of the Open Source ERP system.

1.6 Dissertation Organisation

The dissertation is divided into five chapters. Chapter One, “Introduction” gives the overview of research, namely Introduction to the Problem, Problem Statement, General and Specific Objectives, Research Questions, Hypothesis and Significance of the Study. Chapter Two is the Literature Review” which gives the overview of this study area and summary of the related works reviewed. Chapter Three describes the methodology, research methods and techniques employed in this study. The chapter details how the research has been conducted. Chapter Four, “Findings and Discussion” presents the results of data analysis, discusses findings and presents a model and a tool for selecting Open Source ERP Systems and provides the ranking of the existing systems. The last Chapter Five is the “Conclusion and Recommendations” which concludes the study, provides recommendations and outlines areas of further research.

CHAPTER TWO: LITERATURE REVIEW

2.1 Introduction

This chapter reviews the previous related research conducted in Open Source ERP systems for SMEs and business processes within SMEs. Critical Success Factors for ERP system adoption are also discussed. An ERP system is a significant tool to increase the effectiveness and competitiveness of the SMEs. It enhances the efficiency of the whole business operations in an organisation and increases optimal income [4]. Open Source ERP systems are the one of the fastest growing segments of business computing. The important subject in Open Source ERP system adoption and implementation is how to find a match between the ERP system and an organisation's business processes[26].

2.2 ERP Systems in SMEs

SMEs have been recognised as having different environments as compared to large enterprises [19]. The size and complexity of an organisation plays an important role in implementation of ERP systems [19]. ERP systems are characterized by high costs that rarely can be met by SMEs. Due to their financial constraints they need low cost solutions such as Open Source ERP systems [15]. The awareness amongst SMEs in Botswana about ERP systems is still lower. Only few SMEs know how they can benefit from ERP systems [27]. SMEs face several main issues related to ICT such as low levels of ICT awareness and adoption, underdeveloped IT infrastructure, insufficient funding, undefined operational procedures and business processes [15]. For SMEs to be competitive, they need to equip themselves with necessary tools to support their growth and existence.

There is a difference in ERP system implementation in developed countries and developing countries [28]. The key considerations are costs and resource availability and the significant costs involved discourage SMES in developing countries from implementing ERP systems [28]. The study has examined the requirements especially for Botswana SMEs, to insure the development and implementation of ERP systems which adequately support the underlying business processes of Botswana SMEs.

2.3 Open Source ERP Systems

Open Source Software or programs are those which the source code is made available to other developers to use, modification and improvement. The distribution terms of the Open Source Software must comply with criteria related to distribution, derived works, integrity of the author's Source code, distribution of license and the license terms. ERP systems were traditionally outfitted for large business. ERP system vendors are now finding their way into SMEs. However, SMEs often do not have the necessary resources and budget to purchase commercial ERP systems. The cost of a commercial ERP system includes hardware, license, and implementation [29]. Open Source ERP systems offer an alternative to commercial ERP system. Open Source ERP systems allow for accessible and affordable turn up of adoption. The Open Source ERP systems can be downloaded for free. Then SMEs can try them and evaluate them. Proper selection of an Open Source ERP system is important to SMEs that intends to select such as system [30].

2.4 Advantages of the Open Source ERP Systems

The main advantage of the Open Source ERP systems over commercial alternatives is that the former ones are free to use. Being free to use these makes the Open Source ERP Systems more attractive to the small businesses [31]. The Open Source ERP systems also provide better coverage of the needs of the business due to their scalability. The following are some other advantages of the Open Source ERP systems [32], [33].

- **Flexibility:** The source code for Open Source ERP systems is available for free. Thus an Open Source ERP system allows for interfacing and integration with other systems. Customizing and integration of the Open Source ERP systems with existing legacy systems have become easier to the SMEs because of the availability of free resources and documentation on the internet. SMEs can either do it internally or find external experts.
- **Vendor's independence:** Adopting Open Source ERP systems means that the adopting organisation is not at mercy of the vendor. The support of the system is provided by the Open Source programmer community.
- **Freedom to upgrade:** With Open Source ERP systems, organisation can choose to upgrade the system whenever they want.
- **Ability of adaption to the business environment:** Open Source ERP systems offer the possibility to the client to adapt the system to its environment and business practices. With the proprietary ERP vendors it is up to the client to adapt its business processes to the ERP system [33].

- Possibility of specific developments: Proprietary ERP vendors try to keep control over the collaborative functional modules that a client's organization may need. If a client wishes to carry out specific developments on the system, it is difficult to guarantee what those developments will be compatible with the system.

2.5 Critical Success Factors for ERP Systems Adoption

Critical Success Factors (CSFs) are defined as the limited number of areas in which results, if they are satisfactory, could ensure successful competitive performance for the organisation. CSF of ERP are those conditions that must be met in order for the adoption process to occur successfully [34]. Despite the benefits attained from the implementation and usage of the ERP system in an organisation, not all ERP system adoption and implementations are successful [35]. The successful adoption and implementation of ERP systems has many benefits for an organisation. Adoption of ERP systems needs careful planning and guarding against factors for failure and it is important to consider the factors that might affect the success of the ERP projects [30]. The CSFs discovered from the literature are presented in Table 2.1 below.

Table 2.1: Critical Success Factors for ERP Systems Adoption

S/N	Critical Success Factors	Significance	Reference
1)	Project Management	Project Management ensures that stated objectives of ERP system implementation are achieved.	[12], [30], [34], [35], [36], [37], [38], [39], [40], [41], [42].
2)	Top Management Support	Top Management provides necessary resources and leadership/authority for project success.	[12], [30], [34], [35], [36], [37], [38], [39], [41], [42], [43],
3)	Business Process Re-Engineering	Organisational Business Processes should be matching with the ERP system. Organizations should be willing to change their businesses to fit the ERP systems in order to minimize the degree of customization needed.	[12], [35], [36], [37], [38], [39], [40], [41], [42]
4)	User Training and Education	User Training provides an understanding of the new processes and application as well as the new workflows that are created by ERP	[9], [23], [34], [35], [36], [37], [38], [39], [41], [42]

		system implementation.	
5)	Communication	Communication allows the organisation stakeholders to understand the goals and expected benefits of the ERP systems project.	[12], [29], [30], [35], [36], [37], [38], [39], [40], [41], [42]
6)	IT Infrastructure	ERP package should match with existing systems, i.e. hardware platforms, databases and operating systems.	[12], [30], [34], [36], [38], [39], [41], [42]
7)	Change Management	Change Management requires early participation of all stakeholders affected by the ERP system implementation in order to reduce the chances of resistance of its change.	[12], [34], [36], [37], [38], [39], [40], [41], [42]
8)	Clear Business Goals and Objectives	Clear Business Goals and Objectives [12], provide a guideline for ERP system implementation. It is important to identify business goals before implementing an ERP system.	[34], [35], [34], [36], [38], [41], [42]
9)	User Involvement During Development	User Involvement ensures that users [12], are taking part on defining the organisation's ERP systems needs / requirements as well as on the implementation of the ERP system.	[34], [35], [36], [37], [38], [41], [42]
10)	ERP Strategy (Careful Package selection)	ERP strategy designates what kind of ERP package to be purchased and how will be the implementation process.	[12], [35], [36], [37], [38], [40], [41], [42]
11)	ERP Vendor Support	Due to complexity of an ERP system, it requires the use of the external experts, to support the installation, upgrades of the system and the maintenance of it.	[12], [30], [35], [36], [37], [38], [40], [41], [42]

12)	Budget (Cost of ERP Implementation)	ERP system implementation needs a realistic budget which includes all costs of the implementation, such as those of hardware costs, software, staff resources, and training of staff and customisation of the package.	[12], [29], [30], [35], [36], [37], [38]
13)	Project Champion	Project champions drive the success of the ERP system implementation project, set goals and manage change.	[12], [35], [36], [37], [38], [41], [42]
14)	Monitoring and Evaluation of Performance	Monitoring system performance is needed to identify any alignment problems that may occur and were not apparent.	[12], [35], [36], [37], [38], [40], [41], [42]
15)	Minimal Customization	Organisations try to purchase the ERP package that will fit best into its business process. If more customization is needed on the package, the longer it will take to roll the package out and the more it will cost to keep it up to date.	[12], [35], [36], [37], [40], [41], [42]
16)	Risk Management	Risk Management minimizes the impact of unplanned incidents in the ERP project by identifying and addressing potential risks before significant consequences occur.	[35], [36], [37], [41]
17)	Steering Committee	The Steering Committee provides support, guidance and oversight of progress of the ERP project.	[12], [37], [38], [41]
18)	Project Team Competence	The ERP team project should consist of personnel having the right qualifications and knowledge about the organisational processes.	[12], [35], [37], [38], [41], [42]

To successfully select and adopt an ERP system, it is important for the organisation to consider the factors that might affect the success of the ERP projects. Top Management Support Project Management, Training and Education, Clear Vision and Objectives, Change Management and Communication and the Cost of Implementation were the most frequently cited as the CSFs to the successful implementation of ERP systems. A better understanding of the CSFs will help the practitioners and SMEs managers to improve the chance of success in adopting ERP systems including Open Source ones.

2.6 Related Works in Open Source ERP System Evaluation and Selection

2.6.1 Open Source ERP Systems Selection Survey [24]

Wang and Wang presented carried out a survey for selecting Open Source ERP systems, the survey portrays five criteria namely, (1) completeness of the common required ERP system, (2) easy configuration on a variety of operating systems, (3) existence of large and active social networks for user's support, (4) readiness of Cloud Computing as a web based system and (5) the presence of other non-functional requirements [27]. The authors used these criteria to evaluate six Open Source ERP systems; (1) Open ERP, (2) Opentaps, (3) webERP, (4) PostBooks, (5) Compiere and (6) OpenBravo. The best Open Source ERP system among the six was identified. The survey depicted the highly competitive Open Source ERP system which would address all the above criteria. The limitation of this survey was that it did not include the criteria related to the organisations factors.

2.6.2 Framework for Selecting Open Source ERP Systems [41]

Magnusson proposed a framework for selecting Open Source ERP systems [44]. The framework was used to determine criteria in an e-commerce scenario. The selection part of the framework was intended to support the analysis and comparison of the Open Source ERP systems in order to select the one best suited to the requirements of an adopting organisation. The framework contained both the software specific and project specific criteria as presented in Table 2.2 below.

Table 2.2: Magnusson's Framework for Selecting the Open Source ERP systems[44]

	S/N	Category	Evaluation item
Software	1.1	Functional suitability	Functional fitness Module completion
	1.2	Performance Efficiency	Scalability
	1.3	Compatibility	Interfaces
	1.4	Usability	Ease of operation Ease of learning Internationalization
	1.5	Reliability	Stability Recovery ability
	1.6	Security	Security Permission management
	1.7	Maintainability	Upgradeability Flexible upgrade Ease of integration Ease of in-house development Customization Programming language
	1.8	Portability	Operating System Independence Database Independence Architecture
Project	2.1	Maturity	Development status Reference sites
	2.2	Continuity	Project structure Community activity Transparency Update frequency Lock-in effects
	2.3	Support	Support infrastructure Training Documentation Social network
	2.4	Other	License Total costs Implementation time

The limitation of this framework was that organisational factors which could affect the selection of the Open Source ERP systems were not considered.

2.6.3 Carvalho's Evaluation Method for Open Source ERP Systems [42]

Carvalho proposed an evaluation method for Open Source ERP systems [45]. The evaluation method consists of five phases, known by the acronym PIRCS, which stands for Prepare (Evaluation), Identify (alternatives), Rate (alternatives/attributes), Compare (alternatives) and Select (best alternative). Below is the description of each of the phases.

1. Prepare: This phase initiates the evaluation processes, by defining parameters needed for the evaluation; the stage involves requirements definitions, strategic positioning, and definition of extra attributes, limits set up and measurement method definition.
2. Identify: The phase nominates the candidate Open Source ERP systems. At this stage Web search and visiting portals specializing on the Open Source ERP systems are used.
3. Rate: This entails measuring the value of each attribute for each alternative identified at prepare stage. Rating is divided into two parts:
 - i. Rating the requirements of the system: Evaluating each functional and non-functional requirement according to the established scale.
 - ii. Rating the attributes that define the survivability of the system, a final rate for each attribute of each attribute (candidate) is created.
4. Compare: All the rates from all candidates are taken and a pair to pair comparison or rankings are established. The comparison is performed based on the technique chosen for comparing alternatives.
5. Select: Selection is derived from the comparison; the best ERP among others is selected and adopted by the organisation.

This evaluation method of the Open Source ERP systems lacked a detailed description of the metrics used for the comparison and the evaluation. Software and project criteria guiding the selection of Open Source ERP systems were not taken in consideration on the evaluation.

2.6.4 Al-Saleem's Evaluation Method for Open Source ERP Systems [43]

Al-Saleem proposed Evaluation Method for Open Source ERP system [46]. It was used for evaluation of the three Open Sources ERP systems; (1) Tiny ERP, (2) ERP 5, and (3) SQL

Ledger. The method included following five criteria; (1) Flexibility, (2) Functionality, (3) Support, (4) Continuity, and (5) Maturity. Sub-criteria were extracted from the two criteria being Functionality and Continuity. The Functionality sub-criteria included E-commerce, Accounting and Manufacturing Resource Planning (MRP). The Continuity sub-criteria included Project Structure and Transparency. Priorities were assigned and weights were calculated for the main and sub criteria. Figure 2.1 below present the main and sub criteria used for comparison and evaluation of the three Open Source ERP Systems.

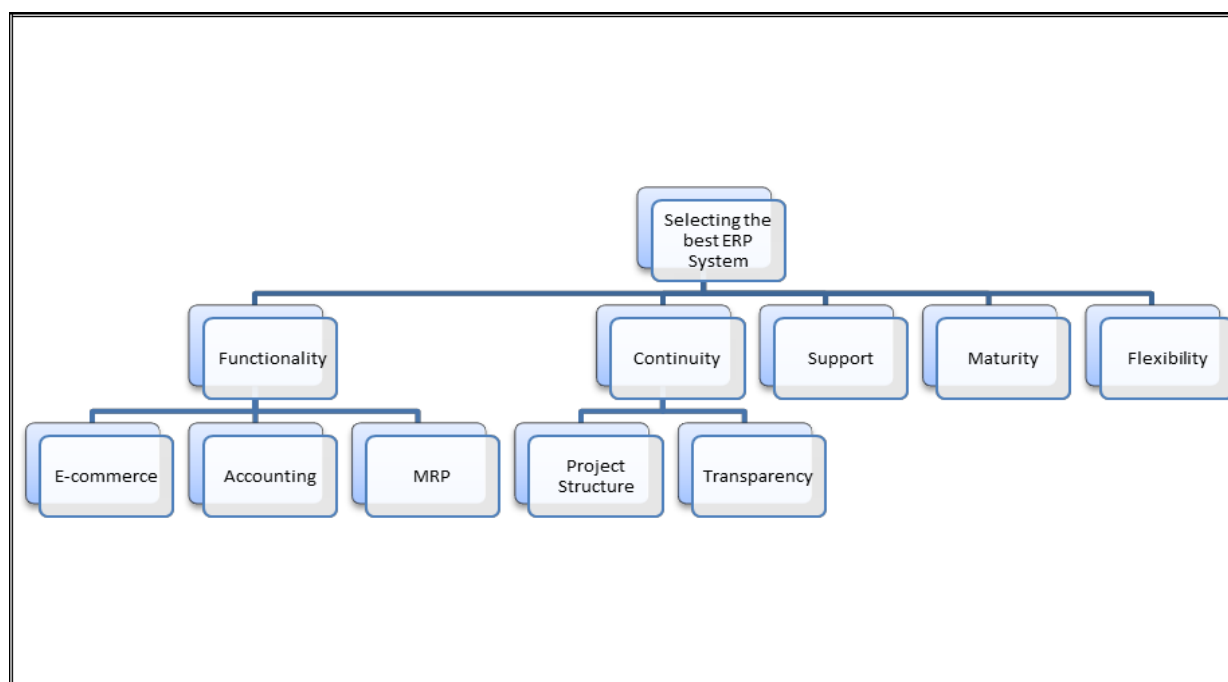


Figure 2.1: Main and sub criteria used for evaluation of Open Source ERP Systems[46]

Based on the five criteria the best ERP system was identified. The limitation of this method was that it did not include evaluation criteria specifically for Open Source ERP systems. The comparison was done for three ERP systems only, thus the validity of the proposed method had not been proven. More Open Source systems needed to be evaluated to validate the method.

2.6.5 Model for Evaluating and Selecting Open Source ERP Systems [27]

Fougatsaro proposed a model for evaluating and selecting Open Source ERP systems [30]. The model included the evaluation criteria to be referred to when considering an Open Source ERP for either SMEs or large organisation. The model was derived from the literature that discussed the ERP systems selection criteria of large and SMEs organisations, as well as features offered by the ERP systems. The model proposed seven dimensions that were being

utilized in the evaluation of the Open Source ERP systems including; (1) Cost, (2) Support Availability, (3) Vision, (4), Stability and Maturity, (5) Customization, (6) Ergonomics and User Interface and (7) Scalability. Three Open Source Systems, namely OpenERP, OpenBravo and Adempiere, were chosen for the evaluation. The model served as guiding principle for evaluating the Open Source ERP systems. The limitation of this model is that the evaluation was done for three ERP systems only, thus the validity of the proposed model had not been proven. Also metrics that evaluate the quality of an Open Source ERP were not considered.

2.6.6 Framework for ERP System Selection Using AHP Method [44]

Rouyendegh and Erkan proposed a framework for selecting ERP system by using Analytic Hierarchy Process (AHP) [47]. AHP method helps in determining the priorities in a set of alternatives. It also determines the relative importance of attributes in a multiple criteria decision-making problem. The framework uses five parameters when selecting an ERP system which are; (1) Total Cost, (2) Implementation Time, (3) Functionality, (4) User-friendliness, and (5) Reliability (see Figure 2.2 below).

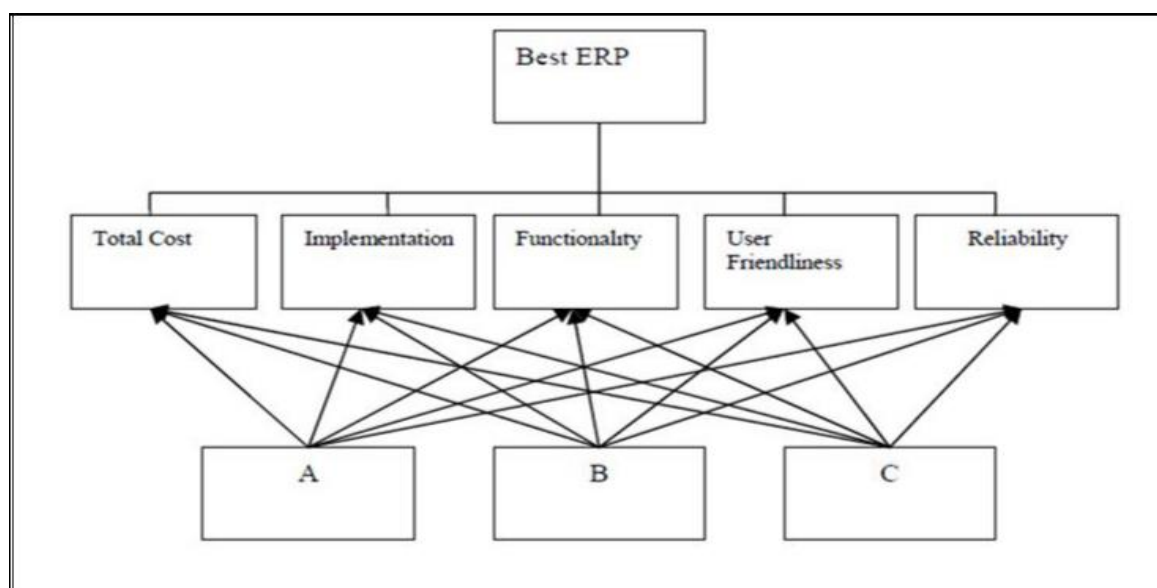


Figure 2.2: Rouyendegh and Erkan's framework for ERP System Selection [47]

This proposed framework was applied in a real-world case in Turkey, so as to demonstrate the feasibility of it. The framework uses five parameters which are; (1) Total Cost, (2) Implementation Time, (3) Functionality, (4) User-friendliness, and (5) Reliability. Basing on these parameters several ERP systems are compared using a numerical scale of 1–9. The limitation of the framework was that organisational factors and software quality

characteristics which could affect the selection of the Open Source ERP systems were not considered.

2.6.7 Theoretical Model for Open Source ERP Systems Selection by SMEs [45]

Huq proposed a theoretical model for Open Source ERP selection by SMEs [48]. This theoretical model consisted of three types of factors. The three factors include; (1) Critical Success Factors that are related to selection of the right ERP package matching the organizational needs, (2) factors that have influence on selection due to the openness of the ERP Systems, and (3) factors that are related to organization size. Figure 2.3 below illustrates the proposed model.

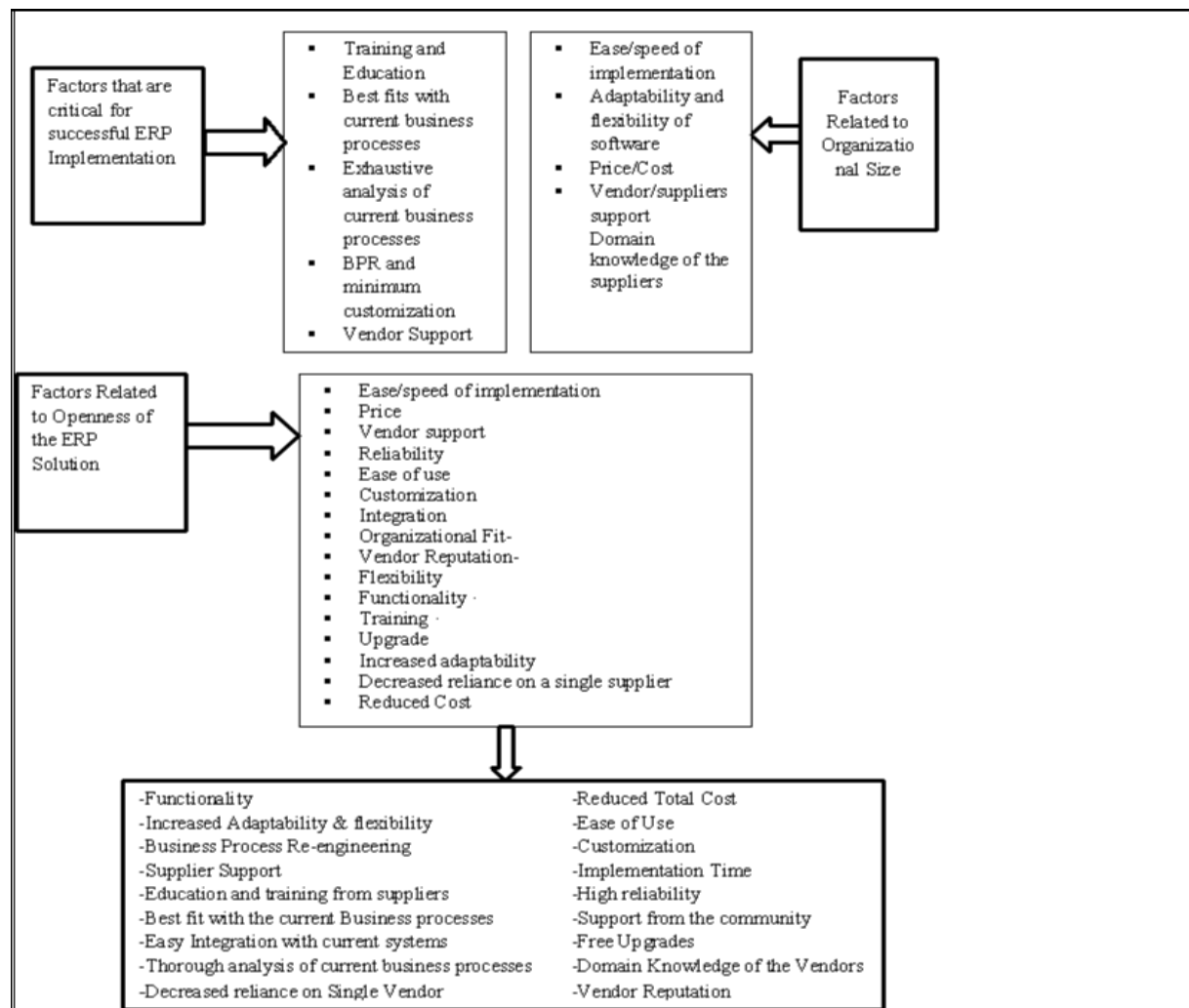


Figure 2.3: Huq's Theoretical Model for Open Source ERP system selection by SMEs [48]

The model presents factors that may motivate SMEs to select Open Source ERP over Proprietary ERP systems. These factors were derived from the literature. The model was not validated as it was not applied in any selection of Open Source ERP systems.

2.6.8 Method for Evaluation of Open Source Customer Relationship Management Software [46]

Yilmaz proposed a method for evaluation of Open Source Customer Relationship Management (CRM) software for SMEs [49]. This method was used for evaluating Open Source CRM software. The method consisted of ten criteria which were used to compare the Open Source CRM software, namely; (1) Functionality, (2) Ease of Use (3) Security, (4) Extensibility, (5) Customization, (6) Compatibility, (7) Scalability, (8) Support and Continuity, (9) Internationalization, and (10) Portability. Under Portability there are sub-criteria which consisted of Operating System Dependence, System Requirements, and Supported Browsers. These criteria were derived from the McCall's quality model and complemented by the criteria of Chaffey and Wood [50]. These criteria had been used to evaluate any software.

This method of evaluating CRM Open Source had not been validated because the evaluated CRM Open Source Systems were not introduced to SMEs; thus the validity of the proposed method had not been proven.

2.6.9 ERP Solution Selection Criteria in Medium-Sized South African Companies [48]

Malie *et al.* presented a study which identified the factors that medium-sized South African companies considered important in the acquisition of an ERP solution [51]. The study identified fourteen criteria namely: (1) Cost (Affordability), (2) Technical Criteria (Infrastructure), (3) Functionality, (4) Service and Support, (5) Vision of the Vendor, (6) System Reliability, (7) Compatibility with Other Systems, (8) Ease of Customisation (Flexibility), (9) Market Position of the Vendor, (10) Compatibility with Organisation Structure (Organisational Fit), (11) Specialised Industry Knowledge, (12) Vendor References, (13) Fit with Parent/Allied Organisation Systems (Corporate Compliance), and (14) Implementation Time.

A questionnaire was developed to test and rate these criteria on a 10-point scale. Research findings confirmed that the fourteen criteria were an adequate and important means of selecting an ERP system. Reliability, Compatibility with existing systems, Service and Support were identified as most important criteria when selecting ERP solution. These

criteria had not been validated by using them to select ERP systems. These selection criteria may possibly be improved by adopting them to real case ERP systems selection so as to validate the proposed criteria.

2.6.10 Enterprise Resource Planning Selection for Railway Industry [49]

The study by Ahat aimed at selecting a suitable ERP for railway industry [52]. Two different railway companies were selected; one was a state owned company and the other one a private sector company. The author identified the selection criteria from literature and past studies. These criteria were then analyzed to determine the suitable selection criteria which were relevant to the study. The study identified five selection criteria including; (1) Cost, (2) Functionality, (3) Flexibility, (4) Ease of Use and (5) Fitting the Organization. Two different multi-criteria decision making methods, namely Analytic Hierarchy Process (AHP) and Technic for Order Preference by Similarity to Ideal Solution (TOPSIS) were applied for selection for these two railway companies. From the calculation of each decision making methods, the results were evaluated for railway industry. The best ERP alternative for railway industry was chosen according to results of the study. The limitation with the study was that it identified few criteria. Moreover, the identified criteria cannot be adopted in selecting ERP systems for various sectors. Also these criteria might not so important when selecting Open Source ERP systems.

2.7 Conclusion

The adequate selection of Open Source ERP systems is important to the SMEs that intend to select or adopt the system [27]. Open Source ERP systems are more difficult to select by SMEs as compared to commercial ERP systems [27], [40]. Technology-Organization-Environment (TOE), Technology Acceptance Model (TAM), and Social Identification Theory (SIT) were used to evaluate and select those Open Source ERP systems [23]. Despite the reputation of these models, there is a lack of appropriate relevant constructs and evaluation criteria which could be used specifically for selecting Open Source ERP systems. Most of the ERP selection models, methods and frameworks reviewed in this chapter focused on the software evaluation criteria and lacked the ERP project management and the organisation criteria which may affect the selection of the Open Source ERP systems. Some are mainly focusing on selecting ERP systems, which would be different to Open Source ERP systems. Moreover, the software evaluation criteria do not consider the system quality

features. There is a need of a model which can be used by SMEs to select Open Source ERP systems, which incorporates more criteria for selecting Open Source ERP systems. Table 2.3 gives a summary of the frameworks and models reviewed in this chapter.

Table: 2.3 Summary of related works in ERP System Evaluation and Selection Models

S/N	Framework / Model / Evaluation Method	Identified Gaps	References
1.	Wang and Wang's survey of Open Source ERP Systems Selection	The survey identified few criteria [27] which are being used to select the Open Source ERP systems; more evaluation criteria of Open Source ERP systems selection should be identified.	
2.	Magnusson's Framework for Selecting Open Source ERP Systems	Organisational factors which can affect the selection of the Open Source ERP systems are not addressed by the framework.	[37]
3.	Carvalho's Evaluation and Selection method for Open Source ERP System	This evaluation method lacked a [26] detailed description of the metrics that are used for the comparison and the evaluation. Software and ERP project criteria are not considered in the evaluation.	
4	Al-Saleem's Comparative Analysis and Evaluation Method of Open Source ERP systems	The comparison and the evaluation method identified few evaluation criteria for Open Source ERP systems.	[33]
5	Fougatsaro's Model for Evaluating and Selecting ERP Systems	The limitation with this model was that the evaluation was done for three ERP systems, thus the validity of the proposed model had not been proven. Also metrics that evaluate the quality of an Open Source ERP were not considered	[30]

6.	Rouyendegh and Erkan's Framework for ERP system Selection Using AHP Method	The limitation of the framework was that organisational factors and software quality characteristics which could affect the selection of the Open Source ERP systems were not considered	[47]
7.	Huq's Theoretical model for Open Source ERP Selection by SMEs	This model was not validated as it was not applied in any selection of Open Source ERP systems.	[48]
8.	Yilmaz's method to evaluate Open Source Customer Relationship Management software	The evaluation method had not been validated because the evaluated CRM Open Source software were not introduced to some SMEs, thus the validity of the proposed method had not been proven.	[49]
9.	ERP Solution Selection Criteria in Medium Sized South African Companies	These selection criteria had not been applied to real case ERP systems selection so as to validate the proposed criteria.	[51]
10.	ERP Selection for Railway Industry Method	The limitation with the study was that it identified only a few criteria. Moreover, the identified criteria could not be adopted in selecting ERP systems for different business sectors other than railway companies. Also these criteria might not be so important when selecting OSS.	[52]

There is a need of a model which can guide selection of Open Source ERP systems selection by SMEs and provide a better understanding of all business processes within an SME. The model should include both software criteria and organisational criteria to guide selection of Open Source ERP systems by SMEs. It should outline CSF for ERP selection. The model should also have the system quality features as part of an evaluation tool.

CHAPTER THREE: RESEARCH METHODOLOGY

3.1 Introduction

This chapter provides information on how the study of the Open Source ERP Systems Selection Model was conducted. The chapter then examines the steps that were taken to achieve the general and specific objectives of this research. The chapter provides a description of the research methodology employed on the research, research design, the research population and sample size. It also provides the description of the methods used for data collection and analysis. The geographic scope of the research was the Palapye sub district. Palapye sub district is located in the central of Botswana. According to the Botswana population census in 2011, statistic Botswana published that the population of Palapye sub district to be 36, 211[53]. Palapye District was chosen because it is an urban area and it was near, finding information regarding the SMEs was easier. The study focused on some selected SMEs, mostly the retailing, health, education, insurance, IT and food-processing companies.

3.2 Sample Size

There are about 243 SMEs registered under the Palapye Administration Authority as of October 2016. The following formula was used for calculating the sample size [54].

Equation 3.1: Sample size formula

$$n = \frac{(1.96)^2 pq}{d^2}$$

Where n = required sample size, p = proportion of the population, $q = 1 - p$ and d = the

degree of precision. Given the population size of 243, confidence level of 95%, and margin of error of 10%, the sample simple size was calculated as 70 respondents (one person from each SME). Questionnaires were distributed to SMEs using the simple random sampling. The response rate was 72.5%. This study targeted the respondents who were computer literate because the questionnaires were distributed only to systems analysts, administrators and IT specialists.

3.3 Research Design

There are two widely adopted research approaches: qualitative and quantitative. Quantitative approach deals with numbers, data and information that is measurable, while qualitative is used to gain an understanding of underlying reasons, opinions, and motivations [55]. A

combination of these the two approaches was used in this research. Qualitative research approach was used to get information about factors which are considered when selecting the Open Source ERP systems and critical success factor for ERP systems.

3.3.1 Qualitative Approach

Qualitative research is concerned with qualitative phenomenon involving quality[55].

Qualitative research deals with the human experience and is based on analysis of words rather than numbers. Qualitative research and analysis provide value in identifying and exploring intangible factors such as cultural expectations, gender roles, ethnic and religious implications and individual feelings [56]. Qualitative research methods seek to explore rich information usually collected from fairly small samples [57]. Qualitative approach was adopted in this research to get information about ERP system development and the information about the adoption levels of these systems in Botswana. The qualitative approach was also employed in this study with the purpose of achievement of in depth understanding of the awareness of ERP systems and the selection of Open Source ERP systems specifically for SMEs. Qualitative research method was used because it is flexible, it allowed a greater freedom and adaptation of the interaction between the researcher and the participants on this research [58].

3.3.2 Quantitative Approach

Quantitative research is based on the measurement of quantity or amount. Quantitative Research is used to quantify the problem by way of creating numerical data or data that can be transformed into useable statistics. The result of quantitative research is essentially a number or a set of numbers [55]. Quantitative research tends to be based on larger sample sizes in order to produce results which can be generalised to a wider population [57].

Quantitative research methods are characterised by the collection of information which can be analysed numerically, the results of which are typically presented using statistics, tables and graphs [56]. In this research quantitative approached was employed in the identification of the Critical Success Factors for the Open Source ERP systems. Characteristics and information about ERP selection criteria were quantified by this approach, the reason being that quantitative research is more representative and reliable [58]. The questionnaire as a quantitative method was used to gather information from the selected SMEs for getting the requirements of the model and also after the Open Source ERP systems were deployed as a way to measure of ERP performance from those SMEs.

3.4 Methods Used for Determining the Components of the Open Source ERP systems Selection Model

To achieve this objective, both primary and secondary data were collected. The two were combined together to derive the components of the model. The data was collected in order to identify the factors affecting the Open Source ERP system selection by SMEs, as well to get an insight on the business processes on SMEs. The SMEs which had adopted ERP systems were also questioned about the benefits anticipated by the use of the ERP systems.

Characteristics of their ERP systems were also assessed. ERP systems knowledge/awareness was also examined by questionnaires from the once that they had not adopted ERP systems. Primary data refers to data collected specifically for the research project being undertaken. Primary data was collected through questionnaires and observation. The collected data collected was analysed using SPSS and Microsoft Excel.

3.4.1 Identification of the Critical Success Factors for the Open Source ERP Systems Adoption

Identification of the Critical Success Factors for the Open Source ERP systems selection was carried out in the following way. First, these criteria or factors were identified through the literature review. Questionnaire on SMEs was then conducted in order to evaluate the people's opinions and perceptions with regard to Critical Success Factors guiding ERP system selection by SMEs.

The questions were formulated in such a way that it was possible to identify new Critical Success Factors. Questionnaires were distributed to the owners, managers and employees of SMEs. The Critical Success Factors were itemised using a Likert scale, in which respondents were asked to indicate their level of importance for each Critical Success Factor using a five-point scale. Descriptive statistics methods namely: mean and standard deviation were used to analyse these factors.

3.4.2 Methods for Identification of the Criteria for the Selection of the Open Source ERP Systems

Identification of the criteria guiding the selection of the Open Source ERP systems by SMEs was also achieved through questionnaire. The identified criteria which were employed in this research for the evaluation and selection of the Open Source ERP systems were derived from past related works. The criteria were made up of the factors that could be used for the evaluation by SMEs when selecting an Open Source ERP system.

The first category of the criteria for the selection the Open Source ERP systems by SMEs was classified into two sets; (1) the factors that were related to the Open Source ERP system and (2) the factors that were related to the adopting organisation. A survey in SMEs was also conducted in order to evaluate the people's opinions and insights about these criteria.

From the first set of the criteria for the selection the Open Source ERP systems by SMEs, thirteen evaluation criteria were identified from the literature and questionnaire; (1) Organizational Size, (2) Cost, (3) Customization, (4) Flexibility, (5) Functionality, (6) Easy to Use, (7) Scalability, (8) Upgrades, (9) Support Availability/ Vendor Support, (10) Internationalisation, (11) Multi-industry, (12) Cloud Capabilities, and (13) Online Demo. The total weight of these criteria was 180. Criteria which appeared to be mostly considered important by the SMEs and which have been used in other studies were assigned a weight of 10, and the less important ones were assigned a weight of five (5), and these criteria are Scalability, Internationalisation, Multi-industry, Cloud Capabilities, and Online Demo.

3.4.3 Methods for Identification of Open Source ERP systems Quality Characteristics

It is important for the Open Source ERP systems for SMEs to meet the system quality criteria. The questionnaire was generated to derive quality metrics which could be used for evaluating the quality of Open Source ERP systems. ISO 9126 is an international standard which has been adopted by the software engineering industry to evaluate the quality of software [59]. The quality of the Open Source ERP systems was evaluated based on the ISO 9126 standard. The questionnaire adopted the ISO 9126 standard quality characteristics, namely; (1) Functionality, (2) Usability, (3) Reliability, (4) Efficiency, (5) Maintainability, and (6) Portability. The questions in the questionnaires were formulated in such a way that it was possible to identify new quality characteristics.

3.5 Methods Used for Evaluation and Ranking of Open Source ERP Systems

Ten Open Source ERP systems were identified and evaluated. Those Open Source ERP systems included; (1) ERPNext, (2) OpenBravo, (3) Odoo, (4) iDempiere, (5) WebERP, (6) OrangeHRM, (7) Compiere, (8) Apache OFBiz, (9) Dolibarr, and (10) LedgerSMB. Identified Open Source ERP systems were mainly developed for small businesses. The systems were evaluated and assigned weights (scores) based on the criteria developed for Open Source ERP systems Selection Model. After the scores allocated to each Open Source ERP systems, they were ranked according the score they attained. From the evaluation, three Open Source Systems which scored the highest were identified and introduced to the selected

SMEs. A survey using questionnaires was also conducted on those SMEs to measure the performance of the selected Open Source ERP systems.

3.6 Methods Used for Validating the Open Source ERP Systems Selection Model

The validation of the Open Source ERP Systems Selection Model was achieved by a survey on the SMEs where the three Open Source ERP systems were introduced. The user satisfaction and overall performance of the ERP systems were evaluated from those SMEs. The balanced scorecard method was adopted for the measurement of ERP performance. The questionnaire survey was developed based on the four dimensions of the balanced scorecard model. The model used four connected dimensions which were Learning and Growth Dimension, Internal Business Processes and Growth Dimension, Customer Dimension and Financial Dimension.

3.7 Conclusion

The chapter gave a detailed description on the research methodology used in this research. The chapter also entailed the methods used for achieving the specific objectives. Further the chapter clarifies on the research design and sample size for this study. It also describes how data was collected and analysed from the research. The table below presents the specific objectives of this study together with the methods to achieve them.

Table 3.1: Specific Objectives and Methods used to achieve them

S/N	Specific Objective	Method(s) used to achieve them
1.	To determine the components of the Open Source ERP Systems Selection Model.	Literature review and questionnaires
2.	To evaluate existing Open Source ERP systems using the proposed model and provide their rankings.	Literature review and questionnaires
3.	To validate the Open Source ERP Systems Selection Model.	Questionnaire and balanced scorecard

CHAPTER FOUR: FINDINGS AND DISCUSSION

4.1 Introduction

This chapter includes the analysis, presentation and interpretation of the results of the data obtained from the study and the model that was developed and derived from the data collection. Data collection in this study was conducted through questionnaires delivered to the owners, managers and employees of SMEs located in Palapye. The results of the data analysis were also presented on this chapter. The Open Source ERP System Selection Model was also presented and described in this chapter.

4.2 Data Collection Results and Discussions

4.2.1 Background Information

The study respondents were business and systems analysts, administrators and IT specialists from the selected SMEs. They had been requested to fill in the questionnaires because they understood concepts of ERP better than respondents with no IT skills. The majority of respondents (46%) were administrators, 33% were either systems or business analysts, and 21% were IT specialists.

In Botswana a Small Enterprise is defined as an enterprise which employs less than 25 employees and a Medium Enterprise is that which employs less than 100 employees [1]. The calculated sample size of this study was 70, as per required by the sample size calculated in Chapter Three, Section 3.2. Out of the 70 questionnaires distributed to the SMEs only 58 were returned and valid to be analysed. The total number of enterprises was 58, and the number of respondents was also 58. Questionnaires returned by respondents which were used to conclude the findings of this study. Out of the 58 SMEs, 29 SMEs had the number of employees between one and eight, 13 SMEs had the number of employees between nine and 17, and nine SMEs had the number of employees between 18 and 25. Lastly seven SMEs had more than 25 employees. This means that most SMEs were at their earliest growth stage, so they would have to consider Open Source ERP systems which had the ability and flexibility to accommodate growth so as to fit new requirements of these SMEs.

4.2.2 ERP System Benefits Indicated by Respondents

From the data analysis it was established that 12% of SMEs had adopted ERP systems, including SAP, eliNext and SAGE 300. However, 88% of SMEs had not implemented ERP systems, thus making evident that there was a need to motivate SMEs to adopt ERP systems,

particularly Open Source ERP systems. The following were some of the benefits of the ERP systems indicated by respondents who were using ERP systems;

- (1) Centralisation of business functions,
- (2) Up to-date information,
- (3) Accurate information for daily routine tasks,
- (4) Better coordination between different departments and improved interdepartmental relations,
- (5) Reduction in overall operating cost and paper work, and
- (6) Overall improvement of business performance.

ERP systems for SMEs facilitate greater productivity and more streamlined data that is available to all departments within a business at all times. When data is easily available and consistently updated, management can make the best decisions for the growth of the SMEs. The management can also have the idea of how the business is operating, which is vital when it comes to responding to changes and improving overall financial planning of the business.

4.2.3 Factors Limiting Adoption of ERP Systems

Respondents from SMEs which had not adopted an ERP system indicated that they would consider selecting and adopting the systems with the aim to reduce business cost, to increase sales volumes and the number of customers and to reduce transaction time.

The analysis of the data collected from respondents had shown that most SMEs had not adopted ERP systems. The common factor preventing the, from adopting ERP systems was the cost of ERP adoption as reflected by 64.7% of the SMEs which did not adopt or implemented the ERP systems. Cost of ERP System adoption had also been identified as the most important Critical Success Factor in this chapter, Subsection 4.3.1. Another common factor was the poor IT skills and infrastructure (45.1%), which scored second in the ranking. Figure 4.1 below presents the distribution of factors limiting or preventing SMEs from adoption of ERP systems.

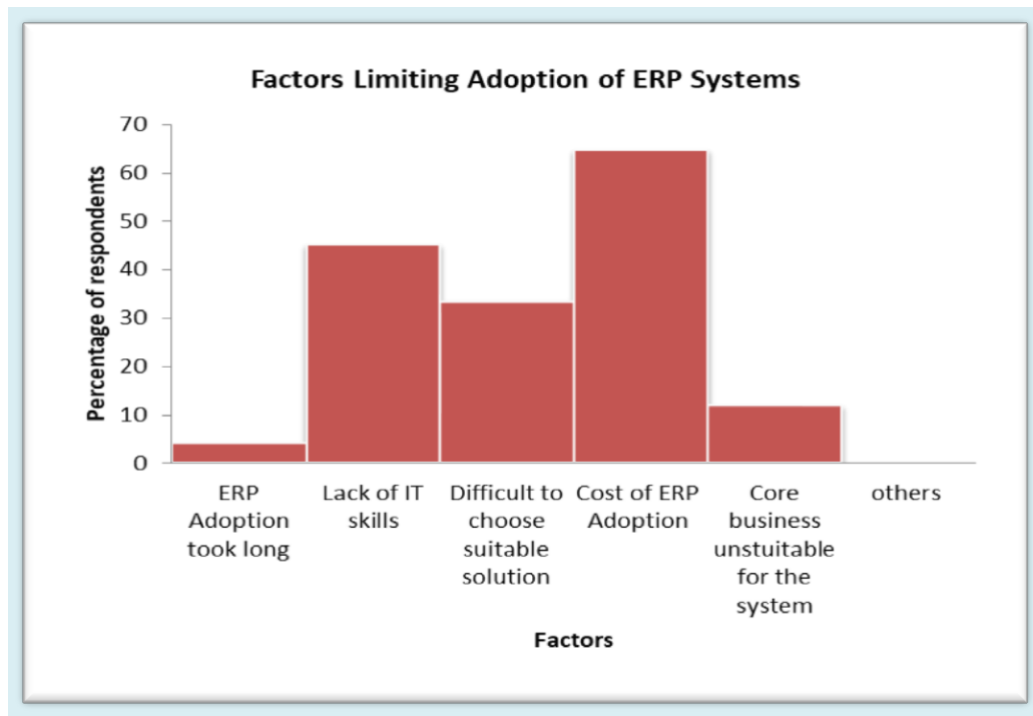


Figure 4.1: Distribution of factors limiting ERP systems adoption among SMEs

ERP selection is very complex and care needs to be taken at all the stages of adoption and implementation and after the system have gone live [6]. The respondents had identified the some of the factors important to ERP systems adoption. Including these factors as the criteria for selecting Open Source ERP systems would make it easier for SMEs to adopt these types of systems.

4.3 Results of Identification of Components of the Open Source ERP System Selection Model

From the data collection the questionnaire responses were analyzed by performing descriptive statistics. The data was collected in order to identify the factors affecting the Open Source ERP system selection by SMEs. Four components of the Open Source ERP System Selection Model were identified. The components include factors that could be used for guiding the selection of Open Source ERP systems.

4.3.1 Results of Identification of the Critical Success Factors for the Open Source ERP System Selection Model

Descriptive statistics was performed on the questionnaire responses. The descriptive statistics method was used because it summarizes the data responses in the way that it captures the important aspects in the data [60]. The Critical Success Factors for ERP selection, the criteria for selecting Open Source ERP systems, factors relating to the adopting organisation and

system quality characteristics were identified from literature and analysed. A survey in SMEs was conducted in order to evaluate the people's opinions and perception with regard to identified factors and criteria. The questions were formulated in the way that it was possible to identify new factors and criteria. These factors and criteria were itemised using a Likert five-point scale, in which respondents were asked to indicate the level of importance for each factor and criteria. The factors measured through descriptive statistics included the mean and standard deviation.

Ranking of Critical Success Factors for ERP Selection

The mean score ranking technique was used for identifying and ranking Critical Success Factors for ERP system selection. The mean score ranking had been proven to be effective to identify Critical Success Factors [61]. The factors with lowest standard deviation from the mean are regarded as the most important factors [61].

The ranking of the Critical Success Factors was based on the calculated mean scores. Factors with small value between standard deviation and mean were considered as the most critical success factors as considered by the respondents. CSFs with large value between the standard deviation and mean were considered less important for ERP system adoption. Table 4.1 presents the rankings of CSFs. The CSFs were ranked in descending order starting with the ones with the least difference between the mean and standard deviation scores.

Table 4.1: Ranking of the Critical Success Factors for ERP system Adoption

S/N	Critical Success Factor (CSF)	Rank (Most considered to least considered)
1.	Budget/ Cost of ERP systems adoption	0.897
2.	Top Management Support	0.926
3.	User Training and Education	0.963
4.	Project Management	0.987
5.	User Involvement During Development	0.992
6.	Clear Goals and Objectives	1.114
7.	Business Process Engineering	1.168
8.	Inter-departmental Communication	1.168
9.	IT Infrastructure	1.168
10.	Risk Management	1.198
11.	Organizational Change Management	1.268
12.	Project Champion	1.425
13.	Project Team Competence	1.484
14.	Careful Package Selection(ERP Strategy)	1.507
15.	ERP Vendor Support	1.524
16.	Monitoring and Evaluation of Performance	1.674
17.	Steering Committee	1.753
18.	Management of Expectations	1.816
19.	Education on New Business Processes	1.857
20.	Minimal Customization	1.903

Budget/Cost of ERP systems adoption scored the mean of 1.53 and the standard deviation of 0.630. Having the lowest value between the mean and standard deviation of 0.897, it appeared to be most important CSF to be considered. It was also indicated (see Subsection 4.2.3) that the cost of ERP system adoption was the most common factor limiting or preventing SMEs from adopting and implementing the ERP system. Top Management Support was the second most important factor with (0.926) as the difference between the mean score and standard deviation values, followed by User Training and Education (0.963),

Project Management (0.987), User Involvement During Development (0.992), Clear Goals and Objectives (1.114), Business Process Engineering (1.168), Communication (1.168), IT Infrastructure (1.168), Risk Management (1.198). Organizational Change Management (1.268) and lastly, Minimal Customization (1.903). This means that this factor was not considered to be an important Critical Success Factor by most SMEs.

ERP systems had shown high failure rate in the past, and it was reported that three quarters of ERP projects were arbitrated to be unsuccessful by the ERP system implementation firms [62]. About 90% of ERP system implementations are late or over budgeted and the success rate of ERP system implementations is about 33% [53]. The benefits of ERP systems can be derived from only a successful implementation. The success of the ERP systems adoption in Botswana SMEs is associated of the following several factors; (1) Budget (Cost of ERP System Implementation), (2) IT Infrastructure, (3) Top Management Support, (4) User Training and Education, (5) User Involvement During Development, (6) Project Management, (7) Clear Goals and Objectives, (8) Business Process Engineering, (9) Communication, and (10) Organizational Change Management. These factors were revealed by the data collection from SMEs owners and employees which took part on the survey. In this chapter, these Critical Success Factors were analysed and ranked according to the most important to be considered by the respondents. These Critical Success Factors are also the mostly cited and have been evaluated in SMEs in India, China, Australia and Germany [63].

4.3.2 Identification of the Selection Criteria for Evaluating an Open Source ERP system

The mean score ranking technique was used for identifying the criteria for selecting Open Source ERP systems. Firstly, the difference between the mean and standard deviation was calculated. The ranking of the selection criteria was based on the calculated difference between the mean and standard deviation scores. The criteria with the lowest difference between standard deviation and mean were regarded as most important to consider when selecting the Open Source ERP systems. Criteria with high scores between the standard deviations and mean were considered as less important. Descriptive statistics for selection criteria Open Source ERP systems for these criteria are presented in Appendix A, Table 1. It presents the rankings of the selection criteria in descending order starting with the ones which are considered most important when selecting Open Source ERP systems.

Cost of Open Source ERP system implementation scored 1.17 for the mean and 0.464 for the standard deviation. Having the lowest value between the mean and standard deviation scores of 0.71, it appeared to be the most important criterion to be considered by SMEs. The second criterion was the Functionality of the Open Source ERP with 0.79 differences, scoring a mean of 1.12 and the standard deviation of 0.329. The remaining criteria were ranked as follows; Flexibility (0.79), Ease to Use (0.80), Customization (0.81), Availability of Upgrades (0.95), Open Source Developer Reputation (1.06), Reliability (1.17), Scalability (1.36), Training, Ease/ Speed of implementation (1.41), Support Availability/ Vendor Support (1.47), Internationalisation (1.49), Multi-industry (1.52).

These criteria were then used for the evaluation of the Open Source ERP Systems. Criteria which were considered most important by the respondents we assigned more weight than the others during the evaluation. Below it is the description of these criteria used for evaluating the Open Source ERP Systems.

a) Cost: One of the first criteria most business consider when buying or implementing an ERP package is cost [64]. Affordability is the essential criterion in the selection process; the solution should have an attractive price. Setting convincing expectations for the overall cost of the system is essential to gain top management approval and support. Costs incurred in implementing Open Source ERP packages include hardware cost, analysis costs, consulting cost, implementation cost, customization cost, integration cost, maintenance cost, user training cost, upgrades and support costs.

b) Functionality: The functionality is what an ERP system was intended to do. It is important for ERP systems to match the current business processes of an organisation and

Open Source ERP systems should be easily adjustable to the changes in the business processes. The functionality of the potential ERP system should be checked to see if it fits with the current organisational business processes.

c) Flexibility: For Open Source ERP systems, the source code it is made available for free and therefore open for integration with other systems. Moreover, customizing and integrating of the Open Source ERP systems with existing systems become easier for the business whether they do it internally or hire external experts, due to the availability of resources and documentation for free. Flexibility is required when selecting Open Source ERP system because the changes in the environment may lead to new business models, which need to be supported without disturbing the end users and on-going business

d) Ease of Use: ERP vendors are trying to get competitive advantage by providing ERP systems which are easy to use. Open Source ERP developers also need to be keeping in mind the end users of their product because they are the ones to use the systems after all. If the ERP system turned to be difficult to use, resistance will build up leading to the failure of ERP system implementation project.

e) Customization: Ease of customization is an important criterion to business seeking to implement an Open Source ERP system [65]. The Open Source ERP systems need to be customised to match the specific needs of the adopting organisation. Open Source ERP vendors are required to provide utilities and tools that will allow in-house IT personnel or independent consultants to customize the software. The degree of functional fit of the Open Source ERP systems determines the amount of customization needed on the system. The higher the fit, the lower implementation and customization costs and the faster is the implementation time.

f) Availability of Upgrades: Open Source ERP systems are upgraded for free, while users of the proprietary ERP system have to pay annual fees or purchase upgrades. There is a relation between customization and the costs for cost of upgrading of ERP systems that are highly customized[31]. Proprietary ERP system vendors are more likely to look deeper into customizations, which might be affected by the upgrade. Concerning support, it is assumed that users of Open Source ERP system always install the newest upgrade and only the latest version is supported. Upgrades for Open Source ERP system appear at time a bug is found or somebody takes effort to program something better or new [65]. Vendors of proprietary or commercial ERP system try to minimize the number of upgrades, since supporting too many versions is costly.

g) Open Source Developer Reputation: The reputation of the Open Source Developer is the evaluation on how they have been offering the services to the previous customers. Better reputation will result in SMEs having a better chance of getting appropriate Open Source ERP system [30].

h) Reliability: Vendors for proprietary ERP systems try to achieve high reliability but community using an Open Source ERP system might be able to find errors faster, since it is larger in numbers and each of them tries to make sense of code.

i) Scalability: An ERP system should be designed to grow with the organisation, Scalability of an ERP system is its ability to continue to function well even if the conditions change in terms of volume and size. Scalability normally comes into a play when the business anticipated growth, whether in the form of number of simultaneous users or transaction performed. When choosing Open Source ERP systems, SMEs need to ensure that the systems can grow as the business grows.

j) Training: Education and Training to the users is vital in the implementing organisation. The amount of training required depend on the ERP systems (how self-explanatory is it and how many functionalities it offers).

k) Ease/Speed of Implementation: This criterion refers to the time required for implementing the ERP system. It also it relates to how fast and easily an ERP system can be implemented. Ease and speed of ERP system implementation does not depend on the graphical user interface and settings one needs to select from nonetheless on the amount of required customization. The ease and speed of ERP system implementation also is determined by requirements collection, analysis and correct understanding.

l) Support Availability /Community Support: An ERP system support is the ability to quickly get to necessary skilled personnel that can customise, support and maintain the system. For proprietor ERP system the users are locked in one vendor, while for Open Source ERP system there is a large community which will support an organisation or an individual implementing a particular Open Source ERP system.

m) Internationalisation: The ERP systems should able to support multiple-languages and be applied in various countries. An ERP system offering the possibility of supporting multiple-languages has an advantage in gaining international popularity and enhancing support from the communities using the Open Source ERP system. International popularity means that support of the Open Source ERP system will be available globally.

n) Multi-industry: This criterion refers to the ability of same ERP system to support several enterprises from different industries. It is important for the same ERP system to support

several enterprises from different industries, because that will mean the ERP systems can be adopted by many enterprises resulting in less cost of customization.

4.3.3 Identification of the Evaluation Criteria Related to the Adopting Organisation

Criteria which affect the selection of an Open Source ERP system by an adopting organisation were also identified through questionnaires. The mean score ranking was also used to rank these factors. The differences between the mean and standard deviation were calculated to determine the factor which is considered most important one by the respondents. The least score difference signified the criterion considered by respondents as the most important one. Table 2 in Appendix A presents a summary of the descriptive statistics for evaluation criteria related to an adopting organisation.

Organizational Size scored the mean of 1.38 and the standard deviation 0.62. The difference between the mean and standard deviation of this factor was 0.76, having been the least value of the factor appeared to be first important criteria to be considered by SMEs when selecting Open Source ERP Systems. The second factor was the Adaptability and Flexibility of the ERP system with 0.83 differences, scoring a mean of 1.64 and the standard deviation of 0.81. The third factor appeared to be the ability of the Open Source ERP System to integrate with the existing systems and applications. The factor had the difference of 0.87. The following factors had the same difference value of 1.10 between the mean and the standard deviation; (1) Short Implementation Time, (2) Lower Costs of the ERP System and (3) Good Support from Supplier and Training. Fit with business processes and the User-friendliness of the ERP system appeared to be less important factors for selecting Open Source ERP system. The two factors had the difference of 1.12 and 1.26 respectively.

Below it is the description of these factors which were derived from the data collection.

- Organisational size: From the perspective of ERP selection, the size of the organization is of interest. SMEs do not have many users and has less business processes so ERP system implementation will took less time, unlike in larger organisation with complex business process which will possible took long.
- Adaptability and Flexibility of the ERP system
This includes technical upgradeability and integration of latest technologies. Flexibility and adaptability are required because of the rapid changing environment, which can likely to bring new business processes which need to be supported without

disturbing the end-users and on-going business. This requires an ERP system having a robust architecture, which would allow for incorporating these new requirements.

- A short Implementation Time of the ERP system

ERP require more time for implementation than any other system. The extensive usage of SME resources for a longer time may negatively affect the core business of the SME. SMEs typically having insufficient resources will not be willing to commit their scare resources to the lengthy implementation, thus SMEs require short ERP systems implementation time.

- Lower Costs of the ERP System

ERP systems are costly in terms of implementation, training, customisation, hosting and any other hidden costs. Financial constraints play a role in the rejection of ERP system by SMEs.

- Fit with business processes

It is necessary for the current business processes to be redesigned so that it is a close match to the ERP system and vice versa. Failure to redesign the process to fit the ERP system may cause problems in implementation, like redundant modules that's is to say, some of the modules of the ERP will be underutilised or having the core business outfitted in the ERP systems

- User-friendliness of the ERP system

End users of the ERP systems should be kept in mind. If the ERP system turns to be difficult to use, resistance will build up leading to the failure of ERP system implementation project

- Integration with the existing systems and applications [66].

Organisation need to fully integrate the ERP systems into their daily operations in order to attain the benefits of the system. Therefore, the integration of the data from the organization's system is critical in the successful implementation of the ERP systems and organisation must be aware of the risks of errors that might occur during integration

- Good support from Supplier and Training

Due to the complexity of the ERP system implementation, end user training is essential for a robust understanding of how the system works and how to use it. Suppliers of these ERP systems should facilitate end user education and trainings and this will consequently maximize ERP benefits and increase user satisfaction.

From the literature the above eight factors were identified. Questionnaire was also used to assess these factors. The factors were categorised to form one component of the Open Source ERP System Selection Model. These factors could help SMEs when selecting Open Source ERP system as it relates to the organisation itself.

4.3.4 Identification of the Open Source ERP System Quality Characteristics

The quality of the Open Source ERP systems was evaluated based on the ISO 9126 standard. It is important for the Open Source ERP system for SMEs to meet the system quality criteria and thus the reason why the ISO 9126 was used for evaluating the quality of Open Source ERP systems in the context of Botswana SMEs. The ISO 9126 is an international standard for software quality evaluation. Six quality characteristics are suggested by this standard: (1) Functionality, (2) Usability, (3) Reliability, (4) Efficiency, (5) Maintainability, and (6) Portability. Each characteristic had several sub- characteristics [59]. The questionnaire was developed based on the above six quality characteristics. Each characteristic had sub-characteristics which were used to assess the quality of the ERP systems and Open Source ERP systems. The evaluation involved the respondents from the SMEs who had selected ERP systems or were in the process of selecting a system. There were 58 respondents and scores were assigned according to the respondents answers. Table 3 in Appendix A presents the percentage of the respondents in relation to each sub-characteristic measured.

The scores are allocated For the Functionality characteristic the respondents indicated that Security and Accurateness of the ERP system were the most critical sub-characteristics to be considered. Security scored 93.1% of the respondents and Accurateness of the recorded 91.4%. Usability characteristic had two most important sub-characteristics: Learnability and Understand-ability of the ERP systems. Understand-ability recorded 89.7% of the respondents and Learnability recorded 86.2%. Efficiency, Time Behaviour, Fault Tolerance and Recoverability under the Reliability characteristic were identified as the key sub-characteristics when measuring the quality of the ERP system. Stability and Changeability under the Maintainability characteristics recorded to be vital; Stability recorded at 91.4% and Changeability at 82.8%. For the last quality characteristic, Portability, Install-ability scored 87.9%, emerging as the most important sub-characteristic. See Appendix D for the sub-characteristics and their descriptions.

4.4 Open Source ERP System Selection Model

Open Source ERP System Selection Model was developed through grouping and categorizing the criteria for the evaluation of the Open Source ERP systems identified from previous works and data collection. The criteria included factors and criteria that could be used for guiding the selection of the Open Source ERP system by SMEs. Two components of the Open Source ERP System Selection Model were used to evaluate the selected Open Source Systems. Figure 4.2 presents the Open Source ERP System Selection Model.

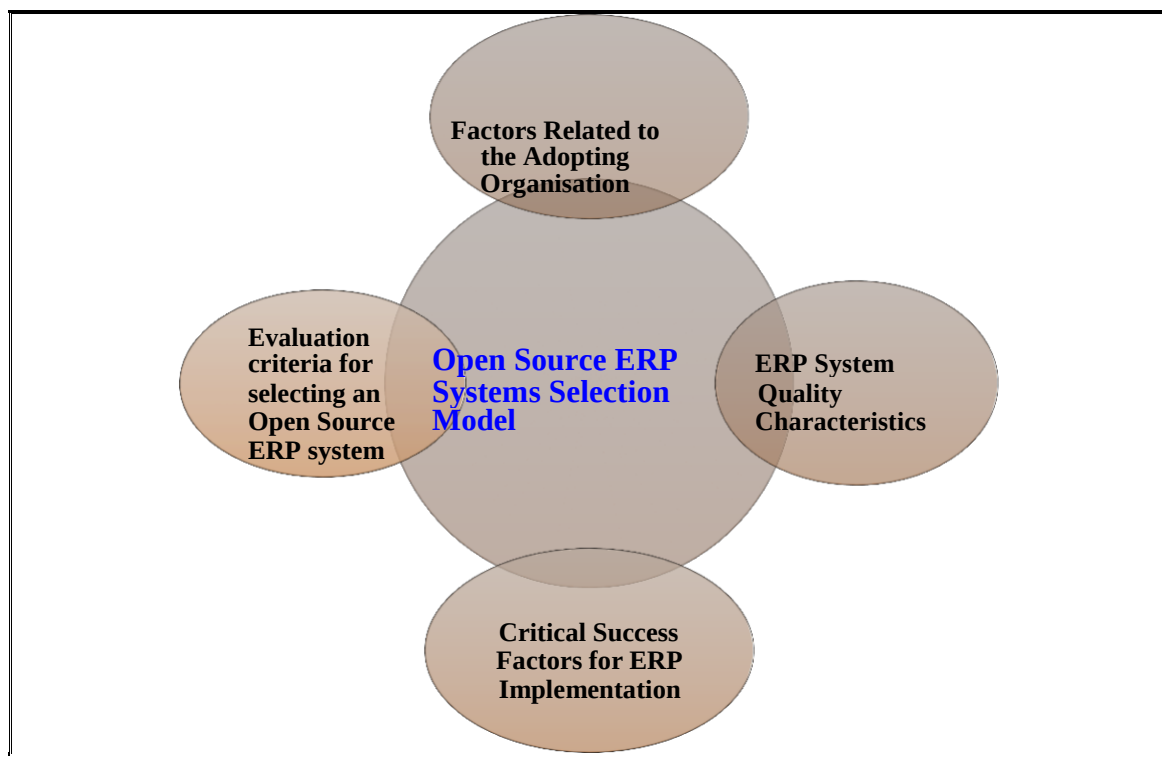


Figure 4.2: Open Source ERP System Selection Model

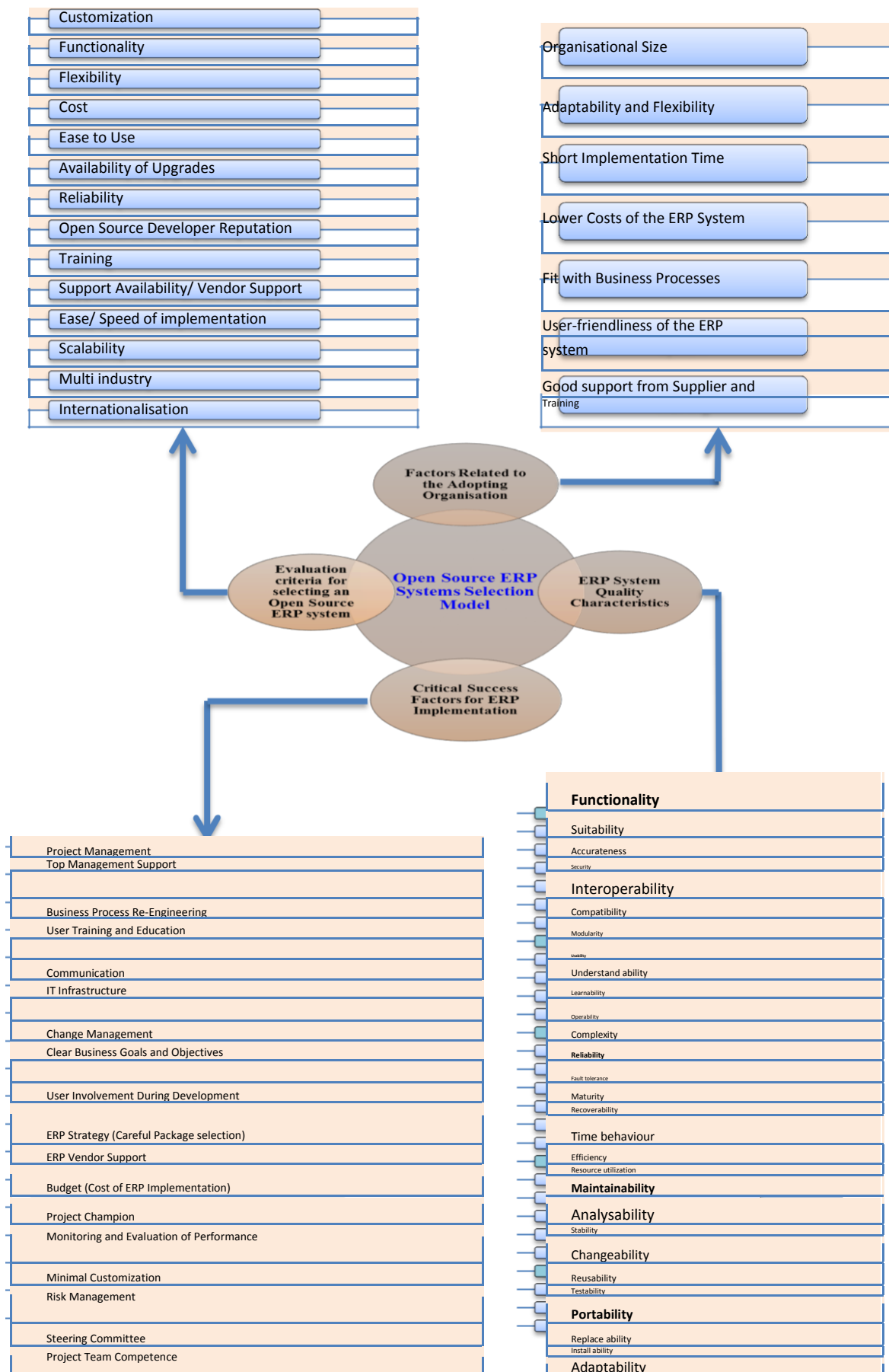


Figure 4.3: A Schematic Diagram for the Open Source ERP system Selection Model

The model is made up four components, which are: (1) evaluation criteria for selecting Open Source ERP system, (2) factors related to the adopting organisation, (3) Critical Success Factors for ERP system implementations, and (4) ERP system quality characteristics. The first component of the Open Source ERP System Selection Model by SMEs is the group of factors related to the evaluation of the Open Source ERP system. These factors could be the used as a guide of some of the criteria which are to be considered when selecting an appropriate Open Source ERP system for SMEs.

The second component is the group of factors related to the adopting organisation. These factors look in the SMEs environment and evaluate the readiness of a SMEs which is about to adopt an Open Source ERP system. The first two components of the Open Source ERP System Selection Model grouped factors which were identified from the literature review and data collection. The third component of the model is the Critical Success Factors for ERP selection. This component was added because the success of ERP system adoption does not solely rely on the system itself (technical aspects). The Critical Success Factors play an important role in the success of ERP systems implementation as well as Open Source ERP systems, because these factors identify conditions which need to be fulfilled in order to avoid ERP Systems implementation failures. The last component of the model is the group of factors that measured the quality of the ERP system. The quality of the Open Source ERP systems was evaluated based on the ISO 9126 standard.

4.5 Results of the Evaluation of the Open Source ERP Systems

An evaluation was performed on the ten Open Source ERP systems. Criteria identified in this chapter, Subsections 4.3.2 and 4.3.3, were used to evaluate these Open Source Systems. Criteria which appeared to be most considered by the SMEs were assigned a weight of ten (10) and the less considered ones assigned weight of five (5). Descriptive statistics was used to determine the weight of the criteria used. From the evaluation the best three Open Source ERP systems were identified out of the ten Open Source ERP Systems. The results of the evaluation of the ten Open Source ERP Systems are in Appendix E.

4.5.1 Evaluation of the Ten Open Source ERP Systems

The first criterion which was used for Open Source ERP systems evaluation was the size of the organisation. All Open Source ERP systems were intended for SME's and all of them, achieved the maximum weight of ten. The functionality offered by these Open Source ERP systems covers the main of the business process of SMEs, namely the Sales and Inventory

Management, Accounting, Human resources, Purchasing and Assets Management. Due to the availability of the source code of these Open Source ERP systems, the customization tends to be easier for most of these Open Source ERP systems. The evaluation revealed that ERP Next, Web ERP, Open ERP, Compiere and Dolibarr were customizable. These Open Source ERP systems allowed customisation to meet the dynamically changing requirements of the SMEs.

The flexibility in the Open Source ERP systems is that the software can be altered and extended by any developer familiar with the source code. Having access to the source code, means that the software or program can be customized to fit the requirements of the SMEs. Only four Open Source ERP Systems namely Dolibarr, ERP Next, Web ERP, and Open ERP, have scores on these criteria. All the Open Source ERP systems had a virtuous usability and were user- friendly (easy to operate), except the Compiere and Opentaps which did not score weights in these criteria. All most all of the evaluated Open Source ERP systems scored weight on the following criteria: Internalisation, Scalability, Multi industry and Cloud Based Capabilities. Opentaps, ERP Next, Web ERP and Open ERP Open Source ERP systems recorded weights with the Upgrade and Support Availability criteria.

4.5.2 Results of Evaluation and Ranking of the Open Source ERP Systems

The evaluation of these systems was based on the criteria identified in this chapter, Sub-section 4.5.1. The identified criteria were assigned a total of 180. Open Source ERP systems were allocated scores based on the criteria and then ranked according the score they attained out of the total 180. Table 4.2 below presents the evaluation results and provides the rankings of the Open Source ERP systems.

Table 4.2: Ranking of the evaluated Open Source ERP Systems

S/N	Open Source ERP System	Score	Percentage
1.	ERP Next	140	77.8
2.	Web ERP	135	75.0
3.	Open ERP	130	72.2
4.	Compiere	125	69.4

5.	Apache OFBiz	115	63.9
6.	Dolibarr	105	58.3
7.	OpenBravo	90	50.0
8.	LedgerSMB	75	41.7
9.	iDempiere	70	38.9
10.	Orange HRM	55	30.6

The results of the evaluation and ranking of the Open Source ERP System revealed three best ones. ERP Next fulfilled most of the outlined criteria with a score of 140, which is 77.8% of the total score. The second best was the Web ERP Open Source ERP system with 75% followed by the Open ERP Open Source with 72.2%. The bottom three Open Source ERP system recorded less scores, the reason being that they did not satisfy most of the outlined criteria and that they were serving a limited number of business function of SMEs. The top three Open Source ERP systems were introduced to the selected SMEs as a way to validate the proposed Open Source ERP System Selection Model. This was done through a survey on the SMEs after using these Open Source ERP systems.

4.6 Results of Validation of Open Source ERP System Selection Model by SMEs

This objective was achieved through the survey in the SMEs where the three Open Source ERP systems were introduced. The user satisfaction and overall performance of the Open Source ERP systems were evaluated in those SMEs. The balanced scorecard method was adopted for the measurement of the user satisfaction and ERP performance of the three systems. The questionnaire survey was developed based on the four dimensions of the balanced scorecard model. The model used four connected dimensions: (1) Learning and Growth dimension, (2) Internal Business Processes and Growth dimension, (3) Customer dimension and (4) Financial dimension [67].

Table 4.3: User satisfaction and ERP systems performance of the three Open Source Systems

S/N	Balanced Score Perspective	Web ERP	Open ERP	ERP Next
1	Perspective 1: Learning and Growth			
1.1	Metric 1: Average response score	0.57	0.67	0.55
1.2	Metric 2: Average response score	0.57	0.55	0.68
1.3	Metric 3: Average response score	0.60	0.66	0.69
	Since there were three metrics in this perspective, they all have a weightage of 0.33. So the performance of this perspective is calculated as:			
2	Perspective 2: Internal Business			
2.1	Metric 1: Average response score	0.59	0.66	0.59
2.2	Metric 2: Average response score	0.57	0.68	0.59
2.3	Metric 3: Average response score	0.41	0.68	0.55
2.4	Metric 4: Average response score	0.59	0.52	0.67
	Since there were four metrics in this perspective, they all have a weightage of 0.25. So the performance of this perspective is calculated as:			

3	Perspective 3: Customer			
3.1	Metric 1: Average response score	0.55	0.55	0.65
3.2	Metric 2: Average response score	0.57	0.60	0.67
3.3	Metric 3: Average response score	0.59	0.67	0.68
	Since there were three metrics in this perspective, they all have a weightage of .033. So the performance of this perspective is calculated as:	$ \begin{aligned} & (.033 \times 0.55) + \\ & (.033 \times 0.57) + \\ & (.033 \times 0.59) = . \end{aligned} $	$ \begin{aligned} & (.033 \times 0.55) + \\ & (.033 \times 0.60) + \\ & (.033 \times 0.67) = . \end{aligned} $	$ \begin{aligned} & (.033 \times 0.65) + \\ & (.033 \times 0.67) + \\ & (.033 \times 0.68) = . \end{aligned} $
4	Perspective 4: Financial			
4.1	Metric 1: Average response score	0.55	0.67	0.64
4.2	Metric 2: Average response score	0.57	0.57	0.67
	Since there were two metrics in this perspective, they all have a weightage of 0.50. So the performance of this perspective is calculated as:	$ \begin{aligned} & (.50 \times 0.55) + \\ & (.50 \times 0.57) = . \end{aligned} $	$ \begin{aligned} & (.50 \times 0.67) + \\ & (.50 \times 0.57) = . \end{aligned} $	$ \begin{aligned} & (.50 \times 0.64) + \\ & (.50 \times 0.67) = 0.655 \end{aligned} $
	Calculation of Overall Performance:	$ \begin{aligned} & (.33 \times .) + \\ & (.33 \times .) + \\ & (.33 \times .) = . \end{aligned} $	$ \begin{aligned} & (.33 \times .) + \\ & (.33 \times .) + \\ & (.33 \times .) = . \end{aligned} $	$ \begin{aligned} & (.33 \times .) + \\ & (.33 \times .) + \\ & (.33 \times .) = . \end{aligned} $

The balanced scorecard method for measuring ERP performance was used and adopted. In this study a scale for measuring the Open Source ERP Source Systems was proposed and used. The same scale was also used by Batada for measuring the performance of ERP systems [67]. User satisfaction and system performance of the three Open Source ERP systems which were introduced to the SMEs were measured using the scale. Table 4.4 below presents a scale that was used to measure the performance of those systems:

Table 4.4: Scale for measuring ERP systems performance

Scale:	Performance	Average mean
1	Excellent	0.81 to 0.10
2	Good	0.61 to 0.8
3	Fair	0.51 to 0.6
4	Poor	0.0 to 0.5

The satisfaction of the users and the overall performance of the Open Source ERP systems were measured to evaluate the success of the Open Source ERP systems Selection Model as a guide of identifying a suitable Open Source ERP system for SMEs.

4.6.1. Web ERP Open Source System

The overall performance score of the Web ERP Open Source systems as calculated above was 0.56, which fell under the ranking of “fair” in the scale, meaning that the performance for all the four perspective measured for this Open Source ERP system needed more improvement. The performance was almost equal in all the perspectives, though, the Financial Perspective scored the least. Based on this evaluation, the Financial Perspective needs more improvement than the other perspectives. This could be improved by decreasing the overall cost of the system implementation as well as by providing more value to its users in terms of decreasing the daily operational costs.

The Learning and Growth perspective indicated 0.58, which fell under the ranking of “fair” in the scale. This indicated that there was room for improvement. The Learning and Growth perspective had the perspective of accuracy of data of the system, productivity of users, reliance on the system of the user and reporting requirements 0.58 fell in the “fair” category, thus perspective needed to be improved in order to rank better.

The Internal Business perspective showed 0.54, which also fell under the ranking “fair” indicating room for improvement in this area. Some of the metrics measured under this perspective included the perspectives of training; ease work load, daily routine operations and the decision making using the system. These perspectives could be improved by organizing more education and training sessions so as to equip users with the skills to use the systems. This would improve the reliance of the system ratio and lastly the user would be able to take decision via the system resulting on better coordination between the departments as well as increased productivity.

Customer’s perspective presented 0.57 which also had “fair” rating and thus could improve by providing functional area support, inter departmental meetings, rewards from the Top Management and User Involvement and Participation. ERP system allows the interconnected departments across the organization, therefore interdepartmental support is essential to increase the ranking of this perspective.

Financial perspective presented 0.56 which also fell under the ranking of “fair”. This indicated a possibility for improvement as well. Improvement in this perspective could help the organization in terms of overall growth, organizational performance as well as a decrease in the overall operating cost.

4.6.2 Open ERP System

The overall performance score of Open ERP Open Source system as calculated above is 0.63, which fell under the ranking of “good” in the scale. This implies that the performances for all the perspective measured for this Open Source ERP system are noble. The performance was almost equal in all the perspectives. Based on this evaluation, the four perspectives can be further improved to excellent category.

The Learning and Growth perspective indicated 0.63, which fell under the ranking of “good” in the scale, which indicates good performance. The perspective has the areas of accuracy of data of the system, productivity of users, reliability of the system, reliance on the system of the user and reporting requirements. The metrics measured in the perspective includes the benefits of how the ERP systems have brought to the adopted SMEs.

The Internal Business perspective presented 0.64, which also fall under the ranking of “good” in the rankings which also indicates room for improvement to the “excellent” category. Some of the metrics measured under this perspective includes the areas of training; ease work load, daily routine operations and the decision making using the system.

Customers perspective presented 0.61 which is also good rating and this can be further improved by providing functional area support, inter-departmental meetings, rewards from the top management and users involvement and participation. ERP system allows the interconnected departments across all the organization, therefore interdepartmental support is essential to increase the ranking of this perspective.

Financial perspective presented 0.62 which also fell under the ranking of “good” also. Further improvement in this perspective performance could include decreasing the overall operating cost and the increasing the overall performance of the organization.

4.6.3 ERP Next Open Source System

The overall performance score of ERP Next Open Source System as calculated above is 0.64, which fell under the ranking of “good” in the scale. The ERP Next Open Source system scored the high performance that the other two. The performances for all the perspective measured for this Open Source are all commendable. The four measured perspectives performance were almost equal.

The Learning and Growth perspective indicated 0.64, which fell under the ranking of “good” in the scale, which indicates a virtuous performance. The metrics measured in the perspective

includes the benefits of how the ERP systems have brought to the adopted SMEs The perspective has areas of accuracy of data of the system, productivity of users, reliability of the system, reliance on the system of the user and reporting requirements.

The Internal Business perspective presented least score among the three perspectives at 0.60. The performance of internal business perspective fell under the ranking of “good”. The metrics measured under this perspective covers the areas in which ERP systems improve the organizational processes as a whole.

Customers’ perspective presented 0.66 which is also in the good rating category, and this can be further improved by providing Functional Area Support, Inter-departmental meetings, rewards from the Top Management and Users Involvement and Participation. ERP system integrate all the departments of an organisation, therefore interdepartmental support is to the ERP systems is essential to increase the ranking of this perspective.

Financial perspective presented 0.65; it fell under the good ranking. Improvement in this perspective performance could include decreasing the overall operating cost and the increasing the overall performance of the organization.

4.6.4 Summary of the Results of Validation of Open Source ERP System Selection Model

The measurement of Open Source ERP system performance is necessary for the organizations which recently adopted the system because organizations can discover the problems after the implementation phase of the ERP system [6]. Measuring the ERP system performance and user satisfaction will enable the adopted organization to make proper improvements. The balanced scorecard approach was adopted to evaluate the three Open Source ERP systems which were introduced to SMEs. The evaluation was based on four major perspectives of the balance score-card. ERP Next Open Source systems presented a high overall performance score of 0.64. The second Open Source ERP was the Open ERP system at 0.63 and lastly the Web ERP Open Source System with 0.56. From the results this means that ERP Next Open Source offered a better system performance and user satisfaction in the SMEs as compared to the other two.

4.7 Conclusion

The main aim of this study was to develop a model that can guide the selection of Open Source ERP systems by SME which was attained. Firstly data was collected in order to identify the factors which could affect the selection Open Source ERP system by SMEs. The result of data collection revealed an Open Source ERP System Selection Model. Four components of the model were identified, which were: (1) Evaluation criteria for selecting Open Source ERP system, (2) factors that related to the adopting organisation, (3) Critical Success Factors for ERP system implementations, and (4) ERP system quality characteristics. The components include factors that could be used for guiding the selection of Open Source ERP systems. The developed Open Source ERP System Selection Model was used to evaluating the Open Source ERP systems. An evaluation was performed on the ten Open Source ERP systems. The results of the evaluation revealed three best Open Source ERP Systems. The Open Source ERP System Selection Model was validated through a survey in the SMEs where the identified best three Open Source ERP systems were introduced.

CHAPTER FIVE: CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

In this chapter, the findings and contribution to this study are summarized, and the general conclusions are also presented. Findings with regard the objectives and research question of this study are also presented. Recommendations on how to increase the endorsement of ERP systems in Botswana are also outlined. Future suggestions of this study were also described in this chapter. Finally, the chapter draws the conclusions from the study.

5.2 Discussion of the Objectives of the Study

The first objective of this study was to identify the components of the Open Source ERP systems Selection Model. Identification of the components of the model was achieved by the use of questionnaires. The model consists of four components. The first component of the model was of the criteria which portrays factors that relates to the evaluation of the Open Source ERP system the second component being the factors related to the adopting organisation. The third component of the model was the Critical Success Factors for ERP selection. The last component of the model is the factors that measure the quality of the Open Source ERP system. Results of those were presented and discussed in Chapter Four.

Questionnaires were conducted from owners, managers and employees of SMEs.

The second objective was to evaluate existing Open Source ERP systems using the proposed model and provide their rankings. An evaluation was performed on the ten Open Source ERP systems using the criteria identified in Chapter Four, Subsections 4.3.2 and 4.3.3. Descriptive statistics analysis was used to determine the weight of the criteria used. Criteria which appeared to be most considered by the SMEs were assigned more weight and the less considered ones were assigned less weight. After the evaluation of the Open Source ERP systems, their rankings were also provided based on the scores they attained. The top three Open Source ERP systems were introduced to the selected SMEs.

The last objective of this study was to validate the Open Source ERP systems Selection Model. This objective was achieved through the survey in the SMEs where the three Open Source ERP systems were introduced. The user satisfaction and overall performance of the Open Source ERP systems were evaluated in those SMEs. The balanced scorecard method was adopted for the measurement of the user satisfaction and ERP performance of the three systems. The questionnaire survey was developed based on the four dimensions of the balanced scorecard model.

5.3 Main Findings and Contribution of the study

This study revealed Open Source ERP systems Selection Model. The model has four components. This component of the model presents the criteria which SMEs can refer to when selecting an Open Source ERP systems. The Model presents criteria which could be used for evaluating the Open Source ERP systems together with criteria which relates to the adopting organisation. The two categories of criteria need to be used together for a better selection of an Open Source ERP System. The Open Source ERP systems Selection Model also presents Critical Success Factors for Open Source ERP systems adoption. A better understanding of the CSFs will help the practitioners and SMEs managers to improve the chance of success in adopting Open Source ERP systems. Lastly the model presents quality characteristics and sub-characteristics which could be used to measure the quality of the Open Source ERP systems when selecting those systems.

This study also revealed the recommendations on Open Source ERP system which could meet the requirements of for SMEs. The recommendations were derived from the identified criteria for the Open Source ERP systems Selection Model. Those recommendations were as follows;

An Open Source ERP system for SMEs must

- a) Be affordable to the SMEs.
- b) Be customized so that it can be modified to match the specific needs of the adopting SME.
- c) Be flexible because there are changes in the environment SMEs operate under, this may lead to new business models, which need to be supported by the Open Source ERP system without disturbing the end users and on-going business.
- d) Provide common ERP system functionalities, for example Accounting Management (order entry, taxation, general ledger, and accounts payable/receivable), Sales and Inventory Management, Purchasing, HRM and CRM.
- e) Be easier to be implemented and be easy to be use (user friendly).
- f) Be able to grow as the business grows (be scalable)
- g) Be reliable and most recent upgrades should be available.
- h) Have support availability/ developer support, a good network for users' community support. Preferable software companies should be able to offer support for the system. Training for the users of the Open Source ERP system also should be obtainable.

- i) Able to support multi-language from various nations as well as the capability to support several SMEs from different industries.
- j) Be ready to capitalise on Cloud Computing, where the SMEs can use the systems anywhere on the Internet; the system must be available online to be downloaded (online demo should be available)
- k) Meet the non-functional requirements of the user SME.

Adopting the Open Source ERP system in SMEs reduces implementation time; reduce the cost of technical support and other fewer operational expenses for commercial ERP system. Introducing Open Source ERP Systems in SMEs, will increase their profit, maximize their efficiency and thereby increase the overall growth and economy of the country.

5.4 Recommendation

Since SMEs play an important role in achieving economic development of any country, Botswana need to introduce initiatives which can help SMEs to grow, namely SMEs must be provided with enticements to adopt Open Source ERP systems. These could be in the form of training packages and skills workshops to help SME workers and owners to overcome the barriers and improve adoption of Open Source ERP Systems

Education and training in Open Source ERP systems development and ERP tools need to be increased to as to improve the uptake of these systems by the SMEs. Lastly financial support can be provided to SME that adopt Open Source ERP Systems. This support can be provided by government agencies such as CEDA and Local Enterprise Authority (LEA).

5.5 Future Research

This research targeted at studying the SMEs. Large organisations have more business processes which are more complex than SMEs. It will be noteworthy to carry out the study on larger organisations. Because their expectations to the Open Source ERP systems are differ to the SMEs. Again the level of giving importance to selection criteria factors of Open Source ERP would also be different to the SMEs. The study was also conducted on SMEs around the one area, namely Palapye sub-district and extending the study to other parts of Botswana can bring better results on validating the proposed Open Source ERP System Selection Model. Another study can be made to check if the selection criteria in developed countries and developing countries regarding the Open Source ERP System differ. Comparison between developed countries and developing countries can possibly bring different results because the licensing issues are different in these countries.

5.6 Conclusion

ERP systems are costly to SMEs. Small and Medium Enterprises should consider Open Source ERP systems to avoid the cost factor. The main advantage of the Open Source ERP systems is that they are free to use, and this should motivate SMEs to use the systems. The Open Source ERP System Selection Model was developed through grouping and categorizing the criteria for the evaluation of the Open Source ERP systems identified from previous works and data collection. The identified criteria were used to derive the components of the model. Statistical analysis was used to validate the identified criteria. The mean score ranking technique was used for identifying the criteria for selecting Open Source ERP systems for all the components of the Model. The criteria with the lowest difference between standard deviation and mean were regarded as most important to consider when selecting the Open Source ERP systems. The statistical analysis is found in Appendix A. The model proposed in this study, presented in Chapter Four, section 4.4 presents the criteria which SMEs can refer to when selecting Open Source ERP systems. Based on the evaluation of the Open Source ERP systems based on the developed model, three out of the ten appeared to be the best for SMEs to select and utilise, namely Open ERP, webERP and ERPnext. The comparison and evaluation of the Open Source ERP systems were based on the following criteria: Cost, Customization, Flexibility, Functionality, Easy to Use, Scalability, Upgrades, Support Availability / Vendor. SMEs are the main users of the Open Source ERP systems. This study presents Open Source ERP systems Selection Model. The model could guide the selection of the Open Source ERP systems which suit the requirements of the SMEs. The model can be applied by the SMEs, because it presents the criteria which SMEs can refer to when selecting an Open Source ERP system. The Open Source ERP Systems Selection Model had been developed by reusing some of the components which had been used to evaluate Open Source ERP Systems as well as selecting those. These components which were reused were made up of criteria which include the factors related to the adopting organisation, Critical Success Factors for ERP and criteria for evaluating the Open Source ERP system. The difference of this proposed model with the existing models and frameworks is that it incorporates components which others did not include in selecting Open Source ERP systems, which are the Critical Success Factors for Open Source ERP systems adoption and factors that measure the quality of the Open Source ERP system. Another difference is that in other studies used only category of factors for evaluating the ERP systems.

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APPENDICES

Appendix A: Descriptive Statistics Calculations

Table 1: Descriptive statistics for selection criteria Open Source ERP systems

Descriptive Statistics				
S/N	Criteria	N	Mean	Std. Deviation
1.	Customization	58	1.07	.256
2.	Functionality	58	1.12	.329
3.	Flexibility	58	1.14	.348
4.	Cost	58	1.17	.464
5.	Ease to Use	58	1.22	.421
6.	Availability of Upgrades	58	1.45	.502
7.	Reliability	58	1.72	.555
8.	Open Source Developer Reputation	58	1.83	.775
9.	Training	58	1.88	.498
10.	Support Availability/ Vendor Support	58	2.02	.546
11.	Ease/ Speed of implementation	58	2.10	.693
12.	Scalability	58	2.24	.885
13.	Multi industry	58	2.50	.978
14.	Internationalisation	58	2.55	1.062

Table 2: Descriptive statistics for Evaluation Criteria (factors) related to the adopting organization

Descriptive Statistics				
S/N	Criteria	N	Mean	Std. Deviation
1.	Organisational Size	58	1.38	0.62
2.	Adaptability and Flexibility	58	1.64	0.81
3.	Short Implementation Time	58	1.67	0.57
4.	Lower Costs of the ERP System	58	1.86	0.76
5.	Fit with Business Processes	58	1.84	0.72
6.	User-friendliness of the ERP system	58	2.03	0.77
7.	Good support from Supplier and Training	58	1.84	0.74

Table 3: Distribution of scores among the ERP systems quality sub characteristics

S/N	Characteristics/Sub Characteristics	Score	%
1	Functionality		
1.1	Suitability	48	82.8
1.2	Accurateness	53	91.4
1.3	Security	54	93.1
1.4	Interoperability	49	84.5
1.5	Compatibility	50	86.2
1.6	Modularity	49	84.5
2	Usability		
2.1	Understand ability	52	89.7
2.2	Learnability	50	86.2
2.3	Operability	46	79.3
2.4	Complexity	47	81.0
3	Reliability		
3.1	Fault tolerance	53	91.4
3.2	Maturity	45	77.6
3.3	Recoverability	53	91.4
3.4	Time behaviour	54	93.1
3.5	Efficiency	55	94.8
3.6	Resource utilization	43	74.1
4	Maintainability		
4.1	Analysability	47	81.0
4.2	Stability	53	91.4
4.3	Changeability	48	82.8
4.4	Reusability	43	74.1
4.5	Testability	42	72.4
5	Portability		
5.1	Replace ability	48	82.8
5.2	Install ability	51	87.9
5.3	Adaptability	49	84.5

Appendix B: Questionnaire



I, Badiredi Seoke, a Masters student in Information Systems at Botswana International University of Science and Technology, kindly request your assistance me with filling this questionnaire. Data collected will be about business processes modelling and ERP modelling, and ERP system development, towards developing OPEN SOURCE ERP SYSTEM SELECTION MODEL_CASE OF: SMALL AND MEDIUM ENTERPRISES IN BOTSWANA. I assure you that the information you provide will be treated with confidentiality and used for academic purpose only.

BACKGROUND INFORMATION:

Position: ☐ Business / System Analyst ☐ Administrator ☐ IT Staff

Number of Employees: ☐ 1-8 ☐ 9-17 ☐ 18-25

PART A: BUSINESS PROCESS INFORMATION

A1.) Which industry domain does your enterprise belong to?

- | | | |
|--|--|---------------------------------------|
| ☐ Agriculture | ☐ Transport/Logistics | ☐ Finance |
| ☐ Retail | ☐ Health | ☐ construction |
| ☐ Public Administration | ☐ Education | ☐ IT |
| ☐ Other (please specify)..... | | |

A2.) Which of the following business functions does your enterprise have?

- | | | |
|---|-------------------------------------|--|
| ☐ Sales and Marketing | ☐ Finance | ☐ Human Resources |
| ☐ Inventory | ☐ Production | ☐ Purchase |
| ☐ Distribution & logistics | | |
| ☐ Other (specify)..... | | |

A3.) Which of the following systems does your enterprise use for your daily operations?

- ☐ Accounting system
- ☐ Purchase system
- ☐ Sales system
- ☐ Inventory system
- ☐ Human resources system
- ☐ Customer Relationship Management
- ☐ Other(s).....

PART B: ERP SYSTEM

B1.) Which of the following factors limits or prevents your enterprise to adopt and implement ERP systems?

- ☐ ERP Implementation took much time
- ☐ Lack of IT skills
- ☐ Difficult to choose the suitable solution
- ☐ Cost of ERP Implementation
- ☐ Other(s) specify

B2.) Which of the following do you consider to be the most important reasons for implementing ERP systems?

- ☐ Keep pace with competitors
- ☐ Reduce business cost
- ☐ Increase sales volume or number of customers
- ☐ Reduce transaction time
- ☐ Other(s) specify.....

B3.) Which of the following modules would you like your ERP systems to have?

- ☐ Sales and marketing
- ☐ Human resources
- ☐ Accounting / Finance
- ☐ Inventory Management
- ☐ Production
- ☐ CRM
- ☐ Distribution and logistics
- ☐ other(s).....

B4.) Which type of database will you prefer for your ERP system?

- ☐ Each business function (department) has its own database
- ☐ Centralised database for all business functions
- ☐ Other Specify:

B5.) Where will you prefer to host your ERP system?

- ☐ On premise (server)
- ☐ Cloud
- ☐ Hybrid

B6.) Which of the following platform will you prefer to use for your ERP system?

- ☐ Computer/Desktop
- ☐ Mobile
- ☐ Both

B7.)Which of the following system quality characteristics and sub characteristics will you consider when implementing an ERP system? (***Tick all which apply***)

Characteristics	Sub Characteristics	✓	Description
Functionality	Suitability		The ERP system which will perform the require functions
	Accurateness		The ERP system which produces anticipated results?
	Security		The ERP system which prevent unauthorised access
	Interoperability		The system which can interact with other system
	Compatibility		The ERP system which can exchange information between its modules and other stand-alone applications
	Modularity		The ERP system which its modules can installed and implemented as a single
Usability	Understand ability		The ERP system which is easy to be used.
	Learnability		The ERP system which can learnt easily
	Operability		The ERP system which work with minimal effort
	Complexity		The ERP's which allows users to interact with variety of the software modules easily
Reliability	Fault tolerance		The ERP system which is capable of maintaining a specified level of performance in case of software and hardware errors
	Maturity		The ERP system which allows software and hardware faults be eliminated over time
	Recoverability		The ERP system which can resume working and recovering the affected data in case of a failure
Efficiency	Time behaviour		The ERP system which can respond quickly
	Efficiency compliance		The ERP system which adheres to the existing efficiency standards
	Resource utilization		The ERP system which can utilize the resources efficiently
Maintainability	Analyzability		The system which require minimal effort in fault identification or diagnose
	Stability		The ERP which its modules can continue functioning after change
	Changeability		The ERP which allows modules be easily modified
	Reusability		The ERP system which its modules can be used in a new project being developed
	Testability		The ERP which allows modified modules to be easily validated
Portability	Replace ability		The likelihood of ERP system being replaced easily with similar system
	Install ability		The ERP which allows modules to be installed easily
	Adaptability		The ERP system which allows modules to be moved easily to other environment

PART C: CRITICAL SUCCESS FACTORS

C1.) Rate by selecting the number which represents the Critical Success Factors to consider when adopting ERP systems

Please select one box for each question.

1=Strongly Agree 2= Agree 3=Neutral 4= Disagree 5=Strongly Disagree

Success Factor	1	2	3	4	5
1) Top management support					
2) Project team competence					
3) Clear goals and objectives					
4) Project management					
5) Project Champion					
6) User involvement during development					
7) User Training and Education					
8) Business Process Engineering					
9) Organizational Change Management					
10) Careful Package Selection(ERP Strategy)					
11) ERP Vendor Support					
12) Management of Expectations					
13) Risk Management					
14) Inter-departmental Communication					
15) IT Infrastructure					
16) Budget (Cost of ERP Implementation)					
17) Education on new business processes					
18) Minimal customization					
19) Steering Committee					
20) Monitoring and Evaluation of performance					
21) Others:					
22)					

PART D: OPEN SOURCE SELECTION CRITERIA

D1) Rate by selecting the number which represents your opinion regarding the selection criteria to consider when adopting Open Source ERP systems

Please select one box for each question.

1=Strongly Agree 2= Agree 3=Neutral 4= Disagree 5=Strongly Disagree

Criteria for evaluating Open Source ERP System	1	2	3	4	5
Customization					
Functionality					
Flexibility					
Cost					
Ease to use					
Upgrades					
Reliability					
Vendor Reputation					
Training					
Support Availability/ Vendor Support					
Ease/ Speed of implementation					
Scalability					
Multi industry					
Internationalisation					
Others:(specify)_____					
Criteria for the adopting organisation					
Organisational size					
Adaptability and flexibility					
Short implementation time					
Lower costs of the ERP system					
Fit with business processes					
User-friendliness of the ERP system					
User-friendliness of the ERP system					
Good support from supplier and training					
Others:(specify)_____					

Appendix C: Statistical Analysis

Descriptive Statistics for Critical Success Factors of ERP implementation

Statistics					
	Top Management Support	Project Team Competence	Clear goals and objectives	Project Management	Project Champion
Valid N	57	57	56	57	57
Missing	0	0	1	0	0
Mean	1.53	2.39	1.73	1.63	2.54
Std. Deviation	.601	.901	.618	.645	1.119
Statistics					
	User involvement during development	User training and Education	Business Process Engineering	Organisational Change Management	Careful Package Selection (ERP Strategy)
Valid N	57	57	57	57	57
Missing	0	0	0	0	0
Mean	1.75	1.56	1.88	2.00	2.25
Std. Deviation	.763	.598	.709	.732	.739

Statistics					
	ERP Vendor Support	Management of expectations	Risk Management	Inter-departmental Communication	IT Infrastructure
N Valid	57	57	57	57	57
N Missing	0	0	0	0	0
Mean	2.33	2.70	2.00	1.88	1.53
Std. Deviation	.809	.886	.802	.709	.630
Statistics					
	Budget (Cost of ERP Implementation)	Education on new business processes	Minimal customization	Steering Committee	Monitoring and Evaluation of performance
N Valid	57	57	57	57	57
N Missing	0	0	0	0	0
Mean	1.53	2.68	2.75	2.63	2.58
Std. Deviation	.630	.827	.851	.879	.905

Descriptive Statistics for User Satisfaction and System Performance

Perspective 1: Learning and Growth												
	Is the ERP data accurate	Are you comfortable to rely on the system information	Are you or your department capable to take care of your reporting requirements using the ERP system	Did the ERP System increase your productivity	The ERP systems provides up to date information	Are you getting required information instantly from the System	The information which was only available via other departments earlier is now available via the system	There is now a strong Information Systems (IS) department in the organisation	Do you have the technical team	Do you have strong and meaningful training programs	Do you now have a decent understanding of ERP concepts	Did you already have a reliable IT infrastructure in place
Mean	1.33	1.40	1.20	1.47	1.40	1.47	1.47	1.47	1.67	2.00	1.60	1.47
N	15	15	15	15	15	15	15	15	15	15	15	15
Std. Deviation	.617	.828	.414	.743	.632	.743	.743	.743	.816	.926	.632	.743

Perspective 2: Internal Business Perspective															
	The ERP System is efficient to take your needs	The ERP System advantageous	The ERP system aid your decision making process	Are you getting good ERP Technical Support	Are you or your department being trained on time	Does the ERP System ease your work load	Does the ERP system provide you with accurate information for your daily routine task	The ERP System provide you with the result for easy work	Did the ERP System implementation reduced paper work	Did the feeling of ownership of the system improve after implementation among the functional users as well as end users	The ERP systems has improved the interdepartmental relationship	Did the overall organisation / departmental productivity improved	The ERP systems provides better coordination between different departments	The ERP system streamlined the business processes	The ERP system increased the overall satisfaction within business processes
Mean	1.13	1.07	1.20	1.60	1.47	1.80	1.20	1.13	1.00	1.33	1.20	1.20	1.00	1.53	1.40
N	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15
Std. Deviation	.352	.258	.414	.737	.743	.775	.414	.516	.000	.488	.414	.414	.000	.516	.632

Perspective 3: Customer												
	Did you get any benefit out of the system utilization	Are you getting timely reports from the ERP system	Was there any user's involvement and participation during system implementation	Do you interact with the system on daily basis	Are you or your team capable to handle the ERP Functional Side	The ERP system is user friendly	The ERP system improves the overall performance	The ERP system simplifies user's task	There was top management support during the system implementation	There was functional areas support during the system implementation	There was a support from the whole organization for the system	You opinion about ERP software selected was considered
N	15	15	15	15	15	15	15	15	15	15	15	15
Valid	2	2	2	2	2	2	2	2	2	2	2	2
Missing												
Mean	1.07	1.00	1.20	1.40	1.33	1.13	1.20	1.07	1.40	1.47	1.47	1.20
Std.	.258	.000	.414	.507	.488	.352	.414	.258	.632	.743	.743	.414
Deviation												

Perspective 4: Financial									
	The ERP system helped in saving end user time	There was a decrease in overall operating cost after implementing the System	There was staff reduction after implementing the system	There was an efficient change management for the ERP system	There was a strategic planning for the ERP Project	Forecasting process has been improved	Are you dependent on the ERP System for your daily operational activities	The system have improved organisational performance	
Mean	1.00	1.20	2.40	1.53	1.67	1.33	1.40	1.27	
N	15	15	15	15	15	15	15	15	
Std.	.000	.414	.910	.834	.816	.617	.632	.594	
Deviation									

Appendix D: ERP System Quality Characteristics

Characteristics	Sub Characteristics	Description
Functionality	Suitability	The ERP system which will perform the require functions
	Accurateness	The ERP system which produces anticipated results?
	Security	The ERP system which prevent unauthorised access
	Interoperability	The system which can interact with other system
	Compatibility	The ERP system which can exchange information between its modules and other stand-alone applications
	Modularity	The ERP system which its modules can installed and implemented as a single
Usability	Understand ability	The ERP system which is easy to be used.
	Learnability	The ERP system which can learnt easily
	Operability	The ERP system which work with minimal effort
	Complexity	The ERP's which allows users to interact with variety of the software modules easily
Reliability	Fault tolerance	The ERP system which is capable of maintaining a specified level of performance in case of software and hardware errors
	Maturity	The ERP system which allows software and hardware faults be eliminated over time
	Recoverability	The ERP system which can resume working and recovering the affected data in case of a failure
Efficiency	Time behaviour	The ERP system which can respond quickly
	Efficiency compliance	The ERP system which adheres to the existing efficiency standards
	Resource utilization	The ERP system which can utilize the resources efficiently
Maintainability	Analyzability	The system which require minimal effort in fault identification or diagnose
	Stability	The ERP which its modules can continue functioning after change
	Changeability	The ERP which allows modules be easily modified
	Reusability	The ERP system which its modules can be used in a new project being developed
	Testability	The ERP which allows modified modules to be easily validated
Portability	Replace ability	The likelihood of ERP system being replaced easily with similar system
	Install ability	The ERP which allows modules to be installed easily
	Adaptability	The ERP system which allows modules to be moved easily to other environment

Appendix E: Evaluation of the Open Source ERP Systems

			Open Source ERP Systems									
S/N	Evaluation Criteria	Weight	Dolibarr	Apache OFBiz	Open ERP	ERP Next	Open Bravo	Web ERP	Orange HRM	Compiere	iDempiere	LedgerSMB
1.	Organisational size	10	10	10	10	10	10	10	10	10	10	10
1.1	SMEs											
1.2	Large											
2.	Functionality		50/90	80/90	60/90	60/90	40/90	60/90	30/90	70/90	40/90	40/90
2.1	Accounting		10	10	10	10	10	10	10	10	10	10
2.2	Sales & Inventory		10	10	10	10	10	10	10	10	10	10
2.3	HRM		10	10	10	10	10	10	10	10	10	10
2.4	CRM		0	10	10	0	0	0	0	10	0	0
2.5	Purchasing		10	10	10	10	10	10	0	10	10	10
2.6	e-Commerce		0	10	0	10	0	0	0	10	0	0
2.7	Project management		0	10	0	0	0	0	0	0	0	0
2.8	Manufacturing Management		0	10	10	10	0	10	0	10	0	0
2.9	Asset Management		10	0	0	0	0	10	0	0	0	0
3.	Customization		10	0	10	10	0	10	0	10	0	0
4.	Flexibility		10	0	10	10	0	10	0	10	0	0
5.	Ease to use		10	10	0	10	10	10	10	0	10	10
6.	Cost		0	0	10	10	0	0	0	0	0	0
7.	Upgrades		0	0	10	0	10	10	0	0	0	0

8.	Support Availability/ Vendor Support	5	0	0	5	5	5	5	0	0	5	0
9.	Internationalisation		5	0	0	5	5	0	0	5	5	0
10.	Scalability		0	5	0	5	0	5	0	5	0	0
11.	Multi-industry		0	5	5	5	5	5	5	5	0	5
12.	Cloud Capabilities		5	0	5	5	0	5	0	5	0	5
13.	Online DEMO		5	5	5	5	5	5	0	5	0	5
	Total	180	105	115	130	140	90	135	55	125	70	75

Appendix F: User Satisfaction and System Performance Questionnaire

User Satisfaction and System Performance of Open Source ERP System

This questionnaire is intended to gather information on the Open Source ERP Systems that have been introduced on your organisation. The questionnaire is aiming to validate the proposed Open Source ERP System Selection Model by SMEs. I assure you that the information you provide will be treated with confidentiality and used for academic purpose only.

Rate by selecting the number which represents the opinion on evaluating the following statement:

Please select one box for each question.

1= Agree 2= neither Agree nor Disagree 3= Disagree

Perspective 1: Learning and Growth

Metric 1:	1	2	3
Question No 1: Is the ERP system data accurate?			
Question No 2: Are you comfortable to rely on the system information?			
Question No 3: Are you or your department capable to take care of your reporting requirements?			
Question No 4: Did the ERP System increase your productivity?			
Metric 2 Question No 5: Are you getting up-to-date information from the System?			
Question No 6: Are you getting required information instantly from the System?			
Question No 7: Did the information which was only available via other departments earlier is now available via the system?			
Question No 8: Does the ERP system offers a strong information systems (IS) Department			
Metric 3 Question No 9: Does your Organisation have the Technical team of the ERP system?			
Question No 10: Did you have strong and meaningful training programs			
Question No 11: Do you now have a decent understanding of ERP concepts			
Question No 12: Did you already have a reliable IT infrastructure in place			

Perspective 2: Internal Business Perspective

Metric 1	1	2	3
Question No 1: Is the ERP System efficient to take your needs?			
Question No 2: Is the ERP System advantageous?			
Question No 3: Does the ERP system aid your decision making process?			
Question No 4: Are you getting good ERP Technical Support?			
Metric 2			
Question No 5: Are you or your department being trained on time?			
Question No 6: Does the ERP System ease your work load?			
Question No 7: Does the ERP system provide you accurate information for your daily routine tasks?			
Question No 8: Does the ERP System provide you the information for easy decision making?			
Metric 3			
Question No 9: Did the ERP System implementation result in reduced paper work			
Question No 10: Did the feeling of ownership of the system improve after the implementation among the functional users as well as end users			
Question No 11: Did the interdepartmental relationships improved			
Question No 12: Did the overall group / departmental productivity improved			
Metric 4 <i>_Due to the ERP systems there is:</i>			
Question No 13: Better coordination in between different departments			
Question No 14: Streamlined the business processes			
Question No 15: Increased overall satisfaction with business processes			
Question No 16: Improve the organizational processes as a whole			

Perspective 3: Customer

Metric 1	1	2	3
Question No 1: Did you get any benefit out of resource utilization?			
Question No 2: Are you getting timely reports from the System?			
Question No 3: There was user's involvement and participation during system implementation			
Question No 4: Do you interact with the system daily?			
Metric 2			
Question No 5: Are you or your team capable to handle the ERP Functional Side			
Question No 6: Is the ERP System user friendly?			
Question No 7: The ERP system improved the performance of the organisation?			
Question No 8: ERP simplifies user task			
Metric 3: <i>(The following were considered during system implementation)</i>			
Question No 9: Top management support			
Question No 10: Functional areas support			
Question No 11: ERP support within the organization			
Question No 12: Your opinion about ERP software selected			

Perspective 4: Financial

Metric 1:	1	2	3
Question No 1: ERP helps in saving end user time			
Question No 2: There a decrease in overall operating cost after implementing the System?			
Question No 3: There was staff reduction after implementing the system			
Question No 4: There was an efficient change management			
Metric 2:			
Question No 5: There was Strategic planning for the ERP Project			
Question No 6: Forecasting process has been improved due to the ERP system			
Question No 7: Are you dependent on the ERP System for your daily operational activities?			
Question No 8: Has the ERP system improved your performance?			