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ENTERPRISE RESOURCE PLANNING APPLICATION IN MATERIALS MANAGEMENT: A STUDY ON HOW COCOA BEVERAGE COMPANIES SELECT OPTIMAL SUPPLIER IN COLUMBIA

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ABSTRACT: *Many CBPCs have seen the massive advantages of implementing ERP packages to facilitate the processing of their numerous functional reporting.* However, the software market is proliferated with ERP packages which have made the *optimal supplier selection very difficult, leading to implementation perils on the part of CBPCs. The objective of this study is to understand how CBPCs in Columbia select their ERP for implementation to support their material management processing needs in particular. The study adopted Multi-attribute Utility Theory (MAUT) to determine which expert attributes of a given ERP package supplier should be considered in ranking to select optimally the best supplier in the software market to ensure successful implementation. Structured questionnaires in the area of Payment Options, Vendor reputation, Software Upgrade/maintenance, Functionality, Easy Customisation and Implementation in the proposed model were sent to expert staffs in CBPCs in Columbia. They were asked to assign numbers from equally preferred to extremely important in preference weight to these variables when they were implementing their ERP package. The results revealed that Vendor Reputation is ranked high with a score of 0.65, followed by Payment Options with 0.64. Software Upgrade followed by 0.55 with Functionality with a score of 0.40, Easy Customisation had a score of 0.35 and implementation with a score of 0.30. Different results may be obtained when expert assessment points are different to suit a company's specific processing needs outside of Columbia.*

KEYWORDS: multi-attribute utility theory, enterprise resource planning, cocoa beverage producing company's, vendor reputation, payment options, functionality

INTRODUCTION

Most businesses, especially those in cocoa industry, computerisation of materials management system has been side-lined to the background due to lack knowledge about its cost effectiveness and efficiency. The complete absence of ERP implementation has led to over/under stocking of cocoa beans for beverage production. This means that companies are investing heavily in materials than is necessary because of the lack of the fusion of Enterprise Resource Planning (ERP). The question is what criteria is used by the beverage companies used to select their respective ERP for implementation to support their materials management to minimize the cost of ordering, storage and production?

Confronted with difficult and unstable business environment, more cocoa producing beverage companies are looking for information systems and technology packaged software to assist them improve their market competitiveness through effective and efficient material management systems. However, these days, there are many Enterprise Resource Planning (ERP) system suppliers in the IT market with man information leading to wrong and sub-optimal supplier selection and wrong ERP package as well. ERP is an integrated and powerful system, for operating different functions such as material/procurement management, accounting, payroll and customer relationship management etc. It enables easy information to flow between each of the business organization's functions which serves as modules in ERP perspective (Hildreth, 2004). Materials management is critical important to all cocoa producing firms due to time and expense involve in delivery to maintain efficient continuous production, especially in the cocoa beverages industry. The cost of cocoa supplies include the raw materials, purchase parts, partially completed cocoa, (work-in-process), finished goods. As a result, cocoa inventories constitute the highest single expenditure of firms engaged in this sector. Therefore, utmost care is needed to guarantee that the materials and parts purchased meet quality specification at the lowest cost of procurement, delivery and storage Jonson et al (2004). Arnold (1998) is of the view that, financially, cocoa inventories forms an essential aspect of every cocoa beverage producing company as a critical study of their balance sheet for example, normally discloses about 60 percent of their total assets. It is therefore imperative to design and implement a computerised materials management throughout the supply chain with well qualified personnel to enhance cost to its barest minimum Zenz (1994). This clearly shows the critical role material management system could play to ensure profit maximisation in the cocoa beverage industry (either public or private) in Columbia in terms of cost reduction and profit maximization and customer satisfaction (He and Li, 2009). However, it is rather unfortunate that many these business organisations have relegated computerisation of material management systems to the backdoor and do not attached importance to it.

Many key happening shows that cocoa beverage companies should adopt ERP system to enable them compete effectively in the global market. Cocoa Beverage Producing Companies (CBPC) are also confronted with how to use the ERP to strengthen their functions to ensure efficiency of operation (Liu, 2009). Malhotra and Temponi (2010) posit that it is necessary for companies such as those in CBPC to implement ERP (Material Management) system to ensure control of

their operations and to succeed in the global market. To implement the ERP system into CBPC requires that CBPC be provided with an ERP package provider and a full integration of all the functions are needed. This research work seeks to understand the criteria CBPC apply when selecting an ERP provider in Columbia.

LITERATURE REVIEW

Today's competitive business environment demands that companies need to make quick, timely and accurate decisions so as to access external information massively to respond to the daily evolving and changes in the global markets (Karaarslan and Gundogar, 2009). As results, ERP package implementation is the optimal solution for both small to big companies who wants to transact their businesses within their home country and globally.

Enterprise Resource Planning (ERP) Package

The term "Enterprise Resource Planning (ERP)" originated from manufacturing resource planning (MRP II) that revised and updated material requirements planning (MRP) (Anderegg, 2010). Davenport (1998) posits that "ERP system is commercial application software which has seamless integration of all the functional information which runs through various operational departments of any company desiring to implement it. It enables companies to optimised information sharing regarding material/procurement, financial and accounting information, human resource information, supply chain information, customer information. Additionally, Su and Yang (2009) suggested that "ERP system is designed with the purpose of automating the flow of material requirement information, and financial resources available among all the functions within business; which can be described as an integrated business computing system. One another way to describe an ERP is a combination of business processes and information technology as the driver.

These days, ERP application is offered by many software providers in the software market with diverse speciality. Therefore, the selection and implementation of ERP software successfully plays a critical role when organizations consider acquiring one (Tsai, et al., 2009). It looks like an ERP system is more popular these das despite the fact that many selection mechanisms are needed in order to select the optimal provider. The variety of CBPCs' requirements in terms of material requirements and how CBPDs select the best ERP support this research study because, nowadays ERP package providers on the market have now focus their attention toward businesses such as CBPDs by offering less expensive and more flexible solutions to them (Chen, 2001). In search for critical decisions for ERP integration and implementation for business, Malhotra and Temponi (2010) posits that ERP implementation is expensive and risky for all businesses, but may be more challenging for SMEs who are CBPCs, which have specialised features. They further argue that an ERP system is complicated and difficult to evaluate in terms of value for money and returns on capital (ROI) as the system has to

integrates different components of computer software and hardware to enable information flow throughout the business organisation.

Meaning of materials and materials management

Jessup et al (1991), posit that material is any physical item/component used by manufacturing industries to process/convert its products or service into finished goods or part-completed. It is made up raw materials, auto spare parts, components, factory supplies, packaging etc. Materials Management deals with production/service and includes the following activities: material purchasing, storage, inventory, and control of external transports, internal transport and material handling. Schaafsma et al (1984) define material management as a controlled flow of materials through the production process of a factory line. The materials flow is regarded as a unit in the production process. Schaafsma, added that, 'materials management is made up of a number of identifiable activities such as production control, procurement, inventory control and goods handling.

Role of Material Management

Manufacturing businesses are confronted with lot of challenges relating to efficient management of materials. The biggest of them all is where agreement is not honoured with the customer to supply the product at the settled period. Such situation do come with disastrous consequences on the company, as the injured client may switch to a new supplier entirely or ask for heavy discounts in the future or sue for potential revenue and profit losses (Batchmaster, 2018). Batchmaster (2018) argues that without material management systems could lead to wastage of money invested in excessive or unused material inventory and the expenses incurred on the warehouse rent on these same materials. These are regarded as dead funds, which can be recovered only when the final product is sold out which is uncertain. The impact of such phenomena can be felt when there is a sudden trigger in demand change, and these inventories no longer holds any relevance. That is precisely the reason why automated material management system is needed, to help companies to ensure inventory optimization & control, cost reduction, and even operations optimization.

The Role of ERP Application in Material Management

ERP application plays a critical role in material management as it ensures that the production operations are planned & scheduled in such a way that only the barest minimum inventory is stored. It also enable the integration of the warehouse, production and delivery schedules to enable manufacturers know how much inventory is available at a given time to only use them as required without wasting any. (Aduamoah et al 2017). Also an ERP's planning module of the package helps ensure that there is enough component materials available for production to enable finished goods to be ready and shipped to the customer on time. All of these functions are interconnected so that the company can determine how much finished goods will be available in the future. In this case, manufacturers can better plan sales, purchasing activities and delivery schedules. Moving on, ERP material requirement planning software also ensures the more efficient use of working capital, thus makes reduced production cost considerably (Batchmaster,2018) Not having over ordered inventory can enable companies make substantial

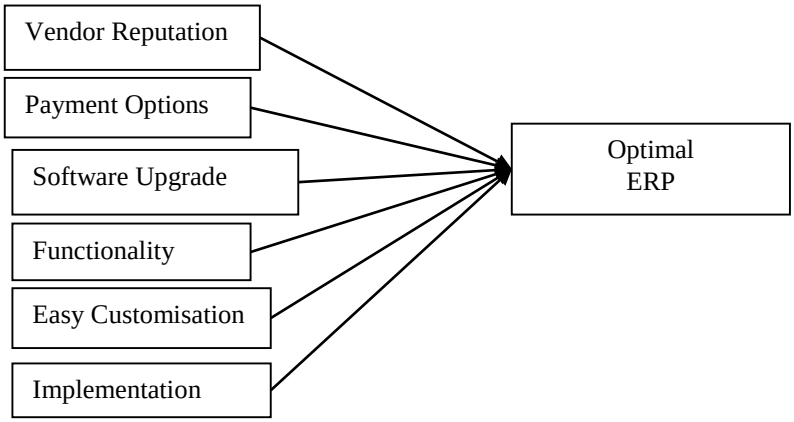
savings on rental costs and any other cost of maintaining the stocks. Then there are other roles too that an ERP can play in material management. It can help with material valuation, which in turn can help determine the material price that has to be recorded for financial accounting (Avraham, 2002). Those manufacturing businesses which operate on a large scale and from multiple locations can benefit from an ERP materials material planning application as a boon to their needs with multi-location inventory tracking with details. Additionally, ERP warehouse management functionality enables the delivery of the inventory at the company's warehouse, stored into bins to facilitate easy picking during order fulfilment process (Aduamoah et al, 2017). Batchmaster (2018) posits that an ERP also ensures the scanning, grouping and tagging of stocks into the system for any future reference, in addition to making the process of inventory replenishment more responsive. The software application (ERP) also comes with lot-tracing capability, to allow the manufacturers to trace and track. The manufacturers can maintain and manage the details about the raw materials lot/serial number, the supplier and the grower etc. from whom the material was sourced and ordered. Any raw material can be easily tracked down in case of non-conformity with quality, quantity and so on.

Proposed ERP Package Selection Criteria for Cocoa Beverage Producing Companies

In general, there are two classes of the conditions that need to be considered in software selection: functional and non-functional (Karlsson, 1997). The functional aspect deals with the core statement which describes the functional role of the application system that is needed by the users. The functional needs usually describe the associations' relationships between all valid (and invalid) inputs into the software application system and the outputs of the software system will generate (Sen, et al., 2009). However, basic features of a system are not covered by its functional description is known as non-functional requirements, which are difficult to draw out, express, quantify and test (Bosch and Molin, 1999; Sen, et al., 2009). Concerning the size of the organization, Bernroider and Koch (2001), indicates that when comparing them with large organization, then organizational flexibility, extra-organizational ties with customers, suppliers and internationality are not an issue as smaller companies pay attention to costs and adaptability of the package software application.

McCall et al. (1977) suggested eleven criteria for upraising the value of the software application desired. However, many researchers have since then stretched and customized those characteristics into diverse criteria based on the suggested eleven. Alanbay (2005) also posits that there are 15 critically important mechanisms for selecting appropriate ERP provider according to the organizations needs such as, customization, implementability, maintenance, real time changes, flexibility, user friendliness, cost, after sales support and training, integrating with other software/applications, financing options and etc. Karsak and Özogul (2009) argue that total cost of ownership, functional fit of the ERP system, user friendliness, flexibility, vendor's reputation, service and support quality are six dimensions of criteria for selection ERP providers suggested by But this study have customised the criteria's in prior studies above and have come out with six main criteria (Figure 1.1) as important implementation strategies for selecting an appropriate ERP

Figure 1.1 Models for the Selection of Optimal ERP



Vendor Reputation: Most literature on the EPR selection criteria speak of vendor reputation no matter the size of the company; either small or large. Normally, there are three attributes to be considered when evaluating ERP vendor reputation which is made up of market share, length of experience and the exhibition of previously successful implementation in other known client companies (Alanbay, 2005).

Payment Options: This includes the ERP cost, Consulting fee and periodic Maintenance/upgrade expenses, and the options available to pay for the deal; either at a lump sum, hire purchase, leasing etc. There are three measurement items when evaluating payment options To select an optimal ERP supplier, cost of implementation is ranked high during the decision process for CBPCs, which includes after-sales service which must be part of the deal with future eventualities during warranty or contractual period; and the cost involved in giving training to employee's on how to use the software package. Celeste, et al., (2003) argues that the annual maintenance costs of some ERPs approximate to about 25% of the original ERP implementation expenses, and upgrade do cost between 25-33% of the original ERP implementation. All of these items must be evaluated and arrive at inherent cost to enable accurate decisions to be made. Aduamoah et al (2017), argues that some computerised accounting software suppliers do hide this inherent expenditure from the company from the initial stage, only to emerge during the upgrade and maintenance period which comes as an unbudgeted expenses to some buying companies.

Software Upgrade: Subsequent ERP maintenance service needs after implementation should be considered at the early stages of the ERP application selection period (Gross, 2010). To evaluate software upgrade of the intended ERP purchase, the following measurement items must be taken into consideration: Compatibility with existing operating system of the

company, security that comes with the new version of the ERP, Migration from the legacy systems to the current system issues, Customisation, the cost of training staff and the availability real-time online inquiry. Users of the ERP should clearly understand software's features and its capability after implementation of the newer version after upgrade (Aduamoah et al 2017). Without periodic software upgrade, would expose the ERP into security vulnerabilities such as confidentiality, integrity and availability. Inability to upgrade the software mean that the companies will enjoy newer ways of doing business both locally and internationally leading to a temporarily freeze in business operations (Kimberling, 2010). Obviously, this variable indicates the services that will be needed subsequent to the implementation and after the ERP system has settled down.

Functionality: According to Ehie et al, (2005). Not all ERP applications can meet all the CBPCs functionalities or unique business needs. This is because companies do have systems which are different from other companies and so do request for ERP that can specially meet such system needs. This normally includes Product Configuration, Distribution Requirements Planning, Quality Assurance/Management, Customer Service Management, Human Resources Management, Sales and Operations Planning, Maintenance Management, Warehouse Management, Transportation Management, Procurement/Material Management etc (Avraham, 2002; Klaus, et al., 2000; Turbide, 1999). Cliff (2006) argues that companies are only utilising about 50% of the ERP functionality implemented and are paying for functions they will never use. So there is the need for CBPCs to ensure that the ERP they select meet their business strategy, else there will be financial losses which may affect their profitability and liquidity positions.

Easy Customisation: This suggests that the ERP system should be easy to use in terms of modification to meet business needs when the critical need arises. The system should not be overly complex in design but have a well-managed interactive user interface. Functions should be easy to locate on the interface; It should not be embedded in another functions for location to be difficult. The ERP should be enabled to support the needs of the business over its lifetime and to also suit the company's culture and business strategy, despite the fact that sometimes business strategies are reviewed along the way as required. Easy to use, possibly, is more important for companies, as such companies sometimes don't have the budget to have adequate in-house IT staff to assist them to use the software application (Chaudhary, 2007).

Implementation: Any ERP packages, implemented in an organization do affect most of the business processes of that company (Malhotra and Temponi, 2010). For example, procurement does affect warehousing, accounts payables, production, inventories etc. As results, customization and ease of integration are critical issues to consider when the need arises for the implementation of ERP system in a company. Because companies demand different application for their business processes, there is the need to make sure that the implementation integrates quickly with other module functionalities to provide seamless data flow (Loh and Koh, 2004). Furthermore, ERP should be able to accept migration of data from the legacy

systems to current application. Many companies do not have the financial muzzle to commit to long ERP implementation times (Cragg and Zinatelli, 1995; Nah and Lau, 2001). Implementation depicts how the new EPR system can be adapted and easily integrated with the company's current system and reduced the time involved during the implementation. The implementation should enable customization to meet the company's short to long term business strategy.

Multi-attribute Utility Theory

Multi-attribute utility theory is a process of using utility functions through the mapping of attributes (criteria) of a variable values into a built scale or mathematical form of preference. Utility, according to (Ang and Tang, 1984) is a measure of appealing or satisfaction which provides a uniform scale to compare and/or combine tangible and intangible criteria. A utility function is a method of quantifying the preference of the decision maker by assigning numerical index to different levels of satisfaction of a criterion to a given goal (Mustafa and Ryan, 1990). Keeney and Wood (1977) applied MAUT to evaluate overall utility of five alternative water resources development plans for the Tisza river basin in Hungary.

The aim of adopting utility theory in decision making process is to come out with a mathematical model to assist the process. This enables the decision maker to quantify the need of certain alternatives. In fact it is commonly used as standard decision making tool in USA and many European countries. As it is multi criteria decision making process with simplicity and easiness in the formulation of a model, it is used in ERP supplier selection process to enable optimal supplier of ERP package among set of alternatives suppliers. MAUT also enables ERP selection to rank attributes of ERP in terms of a given preference when looking for the best supplier who meets such attributes.

Selection of Attributes

Attributes are selected to enable the designer's preference to reflect in the chosen features. The choice of the attribute must be selected to enable usefulness and manageability, and it should also indicate the expected performance of the designed model. Choosing the attributes, must meet the following criteria:

1. Complete to enable important aspects to reflect in the design formulation
2. Operational to enable design decision analysis to be meaningfully after implementation
3. Non-redundant to avoid double counting
4. Must be minimal to enable simplicity

Development of ERP Supplier Selection System

ERP supplier selection is a difficult decision making process which demands simultaneous determination of several decision criteria's, usually conflicting when the decision-making is carried out by a expert panel of multiple decision-makers. Therefore, ERP supplier selection is a multiple criteria decision making problem involving expert subjectivity and uncertainty, which makes the use of linguistic assessment of attributes more appropriate. All ERP supplier selection decisions involve choosing one supplier from among several equally important alternatives. Usually, each alternative is assessed for desirability on a number of scored criteria.

The link between criteria scores and desirability is the utility function. General the formulation of a multi-criteria utility function is the additive model which is depicted below:

Ui> Wj.Uij for all i,
Where
Ui is the overall utility value of alternative i,
uij is the utility value of the jth criterion for the ith alternative
Uij equals u(Xi), for 1 > i > n and 1> j> m
Xi equals (xij,) for 1> i>n and 1 > j>m. Xi designates a specific value of xij
n is the total number of criteria m is the total number of alternatives
Wj is the relative weight of the jth criterion.

Selecting of Best Alternative

Each alternative is assessed by the sum product of utility value assigned to criteria scores (given by decision makers) to the respective indices priorities.

Ui = Σ(PI)j.Uij
Ui = overall utility value of alternative I
Uij = utility value of jth criterion for the ith alternative
(PI)j = indices priority of the jth criterion.

Optimal ERP supplier (best alternative) = highest overall utility value

Table 2.2: Scale of preference between two attributes (Saaty, 2000)

Preference Weight/Level of Importance	**Definition**	**Explanation**
1	Equally Preferred	Two activities equally contributes to the objectives
3	Moderately	An activity strongly or essentially one activity over another
5	Strongly	Experience and judgement strongly or essentially favour one activity over another
7	Very Strongly	An activity is strongly favoured over another and its dominance is demonstrated in practice
9	Extremely	The evidence favouring one activity over one another is of highest degree possible of affirmation
2, 4, 6 and 8	Intermediate values	Used to compromise the above measurement activity values

How then can one derive the weight of each attribute of a model? The way to calculate the weight in the Evaluation process is. an assumption that if the decision maker believes that attribute "Y" is Stronger than attribute "Z", it is rated at 7. On the opposite side, attribute "Z" must be much less important than "Y", so it is valued at 1/7 (Figure 2.3). These paired comparisons are carried out for all factors to be considered.

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RESEARCH METHODOLOGY

This research study adopts the quantitative method of using a step by step approach to understand how CBPCs should select their ERP packages for implementation using Multi Attribute Utility Theory (MAUT). As a result, a structured questionnaire was prepared to aid in the data collection. The questionnaire covered the following areas as proposed in figure 1: ERP Vendor Reputation, Payment Options, Software Upgrade, Functionality, Easy Customisation and Implementation. The questionnaire which was sent to the sample CBPCs consisted of 27 questions. A total of 73 questionnaires were sent to CBPC in Columbia and 44 valid returns were received. This corresponds to a 56 percent return quota. The majority responding companies, representing (79%) currently have currently implemented ERP package system. The data was analyzed by using SPSS package. Demographic data were not collected as the researchers assumed that respondents including managers, owners and staff are of legal age of majority (18years) before being allowed to engage in business establishments and also being employed by these SME businesses. The researchers rather concentrated on the issues confronting SMEs in the selection and implementation of ERP packages instead.

Data Collection from the Questionnaire

Unfortunately, many CBPCs desires to implement an ERP package in their respective companies, but don't have the knowhow to decide to decide an optimal ERP package selection in their company due to the complexity of factors to be considered in selecting the appropriate ERP software package. It is expected that All CBPCs would benefit from a set method Malty Attribute Utility Theory (MAUT) model for decision-making to enable which ERP Provider is the best-fit for them. On the other hand, the ERP Providers who want to enter SMEs market could benefit from this study since they will learn about the criteria for selecting an ERP provider by these companies, in order to assess for themselves whether or not it is feasible for them to provide ERP services for both small and bigger companies. We initially entered the software market to look for popular and potential ERP package suppliers with their prices. We also gathered expert staff assessment about supplier's reputation, payment options available, software upgrade/maintenance, ERP functionality, Easy customisation of ERP and Implementation.

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MAJOR FINDINGS

The results are depicted in table 4.1 below:

Table 4.1 Expert Staff Assessment of ERP Supplier

Initial Data	Payment Options	Vendor Reputation	Software Upgrade	Functionality	Easy Customisation	Implementation
Supplier 1	6.5	7.9	7.5	7.3	7.9	7.1
Supplier 2	6.1	7.3	7.1	7	7.4	9
Supplier 3	7.7	7.5	7.3	5.7	9	7
Supplier 4	5.63	5	8	9	9	7
Supplier 5	5.9	5.9	7	7	8.7	9

(Source: Field Data, 2019)

We then proceeded to determine the maximum and minimum values for each variable pertaining to each ERP software supplier in table (4.1) using the formula given by MAUT to determine the cost and benefits of the ERP package in table 4.2 below:

Cost

$$f_j'(a_i) = 1 + \left(\frac{\min(f_j) - f_j(a_i)}{\max(f_j) - \min(f_j)}\right)$$

Benefits

$$f_j'(a_i) = 1 + \left(\frac{\min(f_j) - f_j(a_i)}{\max(f_j) - \min(f_j)}\right)$$

Table 4.2 Maximum Minimum Determination

	Payment Options	Vendor Reputation	Software Upgrade	Functionality	Easy Customisation	Implementation
Maximum	7.7	7.9	8	9	9	9
Minimum	5.63	5	7	5.7	7.4	7

(Source: Field Data, 2019)

It must be noted that the same formula was applied to three experts' assessment of the ERP suppliers based on the criteria in the model. The next stage is to normalise the details in table 4.1 using the following the following formulae in MAUT to arrive at the details in table 4.3

$$U_1(a_j) = \frac{\exp(f_j'(a_j)^3) - 1}{\exp(1) - 1}$$

Table 4.3 Normalisation of Table of Table 4.1

Normalised	Payment Options	Vendor Reputation	Software Upgrade	Functionality	Easy Customisation	Implementation
Supplier 1	0.5797	1.0000	0.5000	0.4848	0.3125	0.0625

Supplier 2	0.7729	0.7931	0.1000	0.3939	0.0000	0.6061
Supplier 3	0.0000	0.8621	0.3000	0.0000	1.0000	0.0000
Supplier 4	1.0000	0.0000	1.0000	1.0000	1.0000	0.0000
Supplier 5	0.8696	0.3103	0.0000	0.3939	0.8125	1.2500

(Source: Field Data, 2019)

Marginal Utility Score (MUS) is then calculated based on the values in table 4.3 above using the following prescribed formula by MAUT to derive the details in table 4.4:

$$Q_{ij} = \frac{\sum_{k=1}^{l} V(q)_i^k a_{ij}^k}{\sum_{k=1}^{l} V(q)_i^k}, \quad i = 1,\ldots,m,\ j = 1,\ldots,n$$

Table 4 .4 Marginal Utility Score

Marginal Utility Score	**Payment Options**	**Vendor Reputation**	**Software Upgrade**	**Functionality**	**Easy Customisation**	**Implementation**
Supplier 1	0.1252	1.0000	0.5000	0.4848	0.6667	0.4242
Supplier 2	0.3416	0.7931	0.1000	0.3939	0.5152	1.0000
Supplier 3	0.0000	0.8621	0.3000	0.0000	1.0000	0.3939
Supplier 4	1.0000	0.0000	1.0000	1.0000	1.0000	0.3939
Supplier 5	0.5412	0.3103	0.0000	0.3939	0.9091	1.0000

(Source: Field Data, 2019)

The experts weights are then determine by criteria weight, the importance in the grouping regarding each criteria and the importance of grouping regarding each assessment. Table 4 .4 Marginal Utility Score This is achieved by multiplying (V (W)ik) by W_i^k

Table 4.4a Expert Staff 1 Criteria Weight about Each Measurement Item

Weights	**Payment Options**	**Vendor Reputation**	**Software Upgrade**	**Functionality**	**Easy Customisation**	**Implementation**
Criteria Weight Exp1 W_i^k	**0.2**	**0.25**	**0.1**	**0.15**	**0.15**	**0.15**

(Source: Field Data, 2019)

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Table 4.4b Expert Staff 1 Importance in the Grouping

Exp1 Importance Criteria V(W)ik	**Payment Options**	**Vendor Reputation**	**Software Upgrade**	**Functionality**	**Easy Customisation**	**Implementation**
	0.3	**0.25**	**0.15**	**0.1**	**0.15**	**0.1500**

(Source: Field Data, 2019)

Weighted Average W_i^k * V(W)ik

W_i^k * V(W)ik	**Vendor Reputation**	**Payment Options**	**Software Upgrade**	**Functionality**	**Easy Customisation**	**Implementation**
	0.0600	**0.0625**	**0.0150**	**0.0150**	**0.0225**	**0.0225**

(Source: Field Data, 2019)

Table 4.4c Importance in the group Regarding each Assessment

	Payment Options	**Vendor Reputation**	**Software Upgrade**	**Functionality**	**Easy Customisation**	**Implementation**
Exp1 Importance Assessment $V(q)_i^k$	0.2	0.25	0.2	0.15	0.1	0.1

(Source: Field Data, 2019)

We then determine the weighted score for each supplier in terms of price, ERP supplier destination ERP expected duration and discount expected to be given by ERP supplier to enable appropriate ranking of optimally the best supplier. Here the supplier with the highest marginal utility score is selected according to the criteria listed in ***bold*** in the table 4 .5.

Table 4 .5 Weighted Marginal Utility Score

Weighted Marginal Utility Score	**Payment Options**	**Vendor Reputation**	**Software Upgrade**	**Functionality**	**Easy Customisation**	**Implementation**
Supplier 1	0.0250	0.2500	0.1000	0.0727	0.1000	0.0636
Supplier 2	0.0683	0.1983	0.0200	0.0591	0.0773	0.1500
Supplier 3	0.0000	0.2155	0.0600	0.0000	0.1500	0.0591
Supplier 4	0.2000	0.0000	0.2000	0.1500	0.1500	0.0591

Supplier 5	0.1082	0.0776	0.0000	0.0591	0.1364	0.1500

(Source: Field Data, 2019)

It can be seen that in terms of expert 1, no optimally best supplier can be selected because some suppliers values are the same. So the analysis of the expert staff 1 data alone cannot used to select the most appropriate ERP supplier, therefore there is the need to analyze expert 2 data using the same formulae and processes.

Table 4.6 Expert Staff 2 Assessment of ERP Supplier

Initial Data	Payment Options	Vendor Reputation	Software Upgrade	Functionality	Easy Customisation	Implementation
Supplier 1	7.1	7.9	5.65	7.9	7.5	7.5
Supplier 2	7.9	7.2	6.5	9	7.6	5.5
Supplier 3	8	7	7.3	7	7.9	7
Supplier 4	7.5	7.5	6.3	9	6.5	7
Supplier 5	7.3	6.8	5.5	8.1	8.3	8.1

(Source: Field Data, 2019)

Cost

$$f_j'(a_i) = 1 + \left(\frac{\min(f_j) - f_j(a_i)}{\max(f_j) - \min(f_j)} \right)$$

Benefit

$$f_j'(a_i) = 1 + \left(\frac{\min(f_j) - f_j(a_i)}{\max(f_j) - \min(f_j)} \right)$$

Table 4.7 Maximum Minimum Determination

	Payment Options	Vendor Reputation	Software Upgrade	Functionality	Easy Customisation	Implementation
Maximum	8	7.9	7.3	9	8.3	8.1
Minimum	7.1	6.8	5.5	7	6.5	5.5

(Source: Field Data, 2019)

$$U_1(a_j) = \frac{\exp(f_j'(a_j)^3) - 1}{\exp(1) - 1}$$

Table 4 .7 was normalised using the above formulae to arrive at the details in Table 4 .8 blow:

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Table 4 .8 Normalization

Normalization	Payment Options	Vendor Reputation	Software Upgrade	Functionality	Easy Customisation	Implementation
Supplier 1	1.0000	0.3793	0.1500	0.2727	0.3030	0.6061
Supplier 2	0.1111	0.1379	1.0000	0.6061	0.3333	0.0000
Supplier 3	0.0000	0.0690	1.8000	0.0000	0.4242	0.4545
Supplier 4	0.5556	0.2414	0.8000	0.6061	0.0000	0.4545
Supplier 5	0.7778	0.0000	0.0000	0.3333	0.5455	0.7879

(Source: Field Data, 2019)

$$Q_{ij} = \frac{\sum_{k=1}^{l} V(q)_i^k a_{ij}^k}{\sum_{k=1}^{l} V(q)_i^k}, \quad i = 1,\ldots,m,\ j = 1,\ldots,n$$

Based on the formula above, Marginal Utility score is then computed based on table 4.8 to derive the details in table 4.9 below:

Table 4.9 Weighted Marginal Utility Score

Weighted Marginal Utility Score	Payment Option	Vendor Reputation	Software Upgrade	Functionality	Easy Customisation	Implementation
Supplier 1	1.0000	1.0000	0.0833	0.6667	0.5455	1.0000
Supplier 2	0.0008	0.3636	-0.5000	1.0000	0.5758	0.0008
Supplier 3	0.0000	0.1818	0.3000	0.3939	0.6667	0.0000
Supplier 4	0.1089	0.6364	-0.7000	1.0000	0.2424	0.1089
Supplier 5	0.3497	0.0000	-1.5000	0.7273	0.7879	0.3497

(Source: Field Data, 2019)

Table 4.9a Expert Staff 2 Criteria Weight of Each Variable

Weights	Payment Option	Vendor Reputation	Software Upgrade	Functionality	Easy Customisation	Implementation
Criteria Weight Exp2 W_i^k	**0.2**	**0.1**	**0.2**	**0.2**	**0.1**	**0.15**

(Source: Field Data, 2019)

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Table 4.9b Expert Staff 2 Importance in the Grouping Regarding each Variable

Weights	Payment Option	Vendor Reputation	Software Upgrade	Functionality	Easy Customisation	Implementation
Exp1 Importance Criteria V(W)ik	0.2	0.25	0.15	0.1	0.12	0.18

criteria

(Source: Field Data, 2019)

Table 4.9c Expert Staff 2 Importance in the Group Regarding each Variable

	Payment Option	Vendor Reputation	Software Upgrade	Functionality	Easy Customisation	Implementation
	0.23	0.21	0.15	0.1	0.11	0.1

(Source: Field Data, 2019)

Weight of Variable Criteria and Importance of Variable in Grouping

Weights	Payment Option	Vendor Reputation	Software Upgrade	Functionality	Easy Customisation	Implementation
W_i^k * V(W)ik	0.04	0.025	0.03	0.02	0.012	0.0225

(Source: Field Data, 2019)

Table 4.10 Weighted Marginal Utility Score

Weighted Marginal Utility Score	Payment Option	Vendor Reputation	Software Upgrade	Functionality	Easy Customisation	Implementation
Supplier 1	0.2300	0.2100	0.0125	0.0667	0.0545	0.0545
Supplier 2	0.0002	0.0764	-0.0750	0.1000	0.0576	-0.0061
Supplier 3	0.0000	0.0382	0.0450	0.0394	0.0667	0.0394
Supplier 4	0.0250	0.1336	-0.1050	0.1000	0.0242	0.0394
Supplier 5	0.0804	0.0000	-0.2250	0.0727	0.0788	0.0727

(Source: Field Data, 2019)

The details above also do not enable an optimal ERP supplier to be selected as the values sometimes are the same for some suppliers. There is therefore the need to analyse the data from staff expert 3 using the same formulas and processes but with different values.

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Table 4.11 Expert Staff 3 Assessment of ERP Supplier

Initial Data	Payment Option	Vendor Reputation	Software Upgrade	Functionality	Easy Customisation	Implementation
Supplier 1	5.3	7.1	8.3	8.1	7.1	8
Supplier 2	5.9	8.4	5.9	9	7.5	7
Supplier 3	7.5	7.5	7.9	8.1	7.5	5
Supplier 4	7.3	6.8	7.3	9	7.5	6
Supplier 5	8.1	6.8	4.8	9	7.9	7.4

(Source: Field Data, 2019)

Cost

$$f_j'(a_i) = 1 + \left(\frac{\min(f_j) - f_j(a_i)}{\max(f_j) - \min(f_j)}\right)$$

Benefits

$$f_j'(a_i) = 1 + \left(\frac{\min(f_j) - f_j(a_i)}{\max(f_j) - \min(f_j)}\right)$$

Table 4.12: Determining Minimum and Maximum Values from Table 4.11

Min/Max	Payment Option	Vendor Reputation	Software Upgrade	Functionality	Easy Customisation	Implementation
Maximum	8.1	8.4	8.3	9	7.9	8
Minimum	5.3	6.8	4.8	8.1	7.5	5

(Source: Field Data, 2019)

$$U_1(a_j) = \frac{\exp(f_j'(a_j)^3) - 1}{\exp(1) - 1}$$

Table 4.13 Normalization table 4.11 Values

Normalised	Vendor Reputation	Payment Options	Software Upgrade	Functionality	Easy Customisation	Implementation
Supplier 1	1.0000	0.1034	3.5000	0.0000	0.0000	0.9091
Supplier 2	0.7857	0.5517	1.1000	0.2727	0.1212	0.6061
Supplier 3	0.2143	0.2414	3.1000	0.0000	0.1212	0.0000
Supplier 4	0.2857	0.0000	2.5000	0.2727	0.1212	0.3030
Supplier 5	0.0000	0.0000	0.0000	0.2727	0.2424	0.7273

(Source: Field Data, 2019)

Table 4.14 Weighted Marginal Utility Score

Marginal Utility Score	Vendor Reputation	Payment Options	Software Upgrade	Functionality	Easy Customisation	Implementation
Supplier 1	1.0000	0.1875	1.0000	0.0000	-1.1111	-0.1111
Supplier 2	0.3633	1.0000	0.3143	1.0000	-0.6667	-1.2222
Supplier 3	0.0058	0.4375	0.8857	0.0000	-0.6667	-3.4444
Supplier 4	0.0137	0.0000	0.7143	1.0000	-0.6667	-2.3333
Supplier 5	0.0000	0.0000	0.0000	1.0000	-0.2222	-0.7778

(Source: Field Data, 2019)

$$Q_{ij} = \frac{\sum_{k=1}^{l} V(q)_i^k a_{ij}^k}{\sum_{k=1}^{l} V(q)_i^k}, \quad i = 1,\ldots,m,\ j = 1,\ldots,n$$

Table 4.15a Expert 2 Criteria Weight of Each Variable

Weights	Vendor Reputation	Payment Options	Software Upgrade	Functionality	Easy Customisation	Implementation
Criterial Weight Exp1 W_i^k	**0.23**	**0.23**	**0.21**	**0.17**	**0.16**	**0.18**

(Source: Field Data, 2019)

Table 4.15b Expert 2 Importance in the grouping regarding each Variable criteria

	Vendor Reputation	Payment Options	Software Upgrade	Functionality	Easy Customisation	Implementation
Exp1 Importance Criteria V(W)ik	**0.21**	**0.26**	**0.13**	**0.17**	**0.12**	**0.11**

(Source: Field Data, 2019)

Table 4.15c Expert 2 Importance in the group regarding each assessment Variable

	Vendor Reputation	Payment Options	Software Upgrade	Functionality	Easy Customisation	Implementation
Exp3 Importance Assessment $V(q)_i^k$	**0.21**	**0.19**	**0.2**	**0.15**	**0.14**	**0.11**

(Source: Field Data, 2019)

Table 4.17 Aggregate Weight

	Payment Options	Vendor Reputation	Software Upgrade	Functionality	Easy Customisation	Implementation
W_i^k * V(W)ik	0.0483	0.0598	0.0273	0.0289	0.0192	0.0198

(Source: Field Data, 2019)

Table 4.16 Weighted Marginal Utility Score

Weighted Marginal Utility Score	Payment Option	Vendor Reputation	Software Upgrade	Functionality	Easy Customisation	Implementation
Supplier 1	0.3000	0.3500	0.1579	0.0236	0.0150	0.0129
Supplier 2	0.3000	0.2500	0.0000	0.0857	0.0193	0.0150
Supplier 3	0.0000	0.0500	0.0947	0.0000	-0.0021	0.0600
Supplier 4	0.0004	0.0000	0.2000	0.0429	0.0000	-0.0214
Supplier 5	0.2191	0.2000	0.1316	0.1500	-0.0321	-0.0514

(Source: Field Data, 2019)

We then determined the aggregate weight by using the formulae below:

$$W_i = \frac{\sum_{k=1}^{l} V(w)_i^k w_i^k}{\sum_{k=1}^{l} V(w)_i^k}, \quad i = 1,\ldots,m$$

This formula derived the result below in table 4.18:

Table 4.18 Aggregate Expert 1to 3 Importance Assessment $V(q)_i^k$

	Payment Options	Vendor Reputation	Software Upgrade	Functionality	Easy Customisation	Implementation
Aggregate Weight	0.3783	0.2348	0.1173	0.1114	0.0462	0.0573
Aggregate v(w)	0.7100	0.7600	0.4300	0.3700	0.4300	0.3700
	0.5328	**0.3089**	**0.2728**	**0.3011**	**0.1074**	**0.1549**

(Source: Field Data, 2019)

This enable us to determine the weight of each variable in the table.

$$U_j = \frac{\sum_{i=1}^{m} W_i Q_{ij}}{\sum_{i=1}^{m} W_i}, \quad j = 1,\ldots,n$$

We then used the formula below to derive the sum total of all the each variable importance in the group in terms of the assessment in table 4.19:

$$U_j = \frac{\sum_{i=1}^{m} W_i Q_{ij}}{\sum_{i=1}^{m} W_i}, \quad j = 1,\ldots,n$$

Table 4.19 Aggregate Staff Expert 1to 3 Importance Assessment $V(q)_i^k$

	Payment Option	**Vendor Reputation**	**Software Upgrade**	**Functionality**	**Easy Customisation**	**Implementation**
SUM V(q)	**0.64**	**0.65**	**0.55**	**0.4**	**0.35**	**0.31**

(Source: Field Data, 2019)

It can be seen from table 4.18 that in terms of the weighted aggregate, vendor reputation ranks high in importance when selecting ERP supplier with a point of 0.5328. This is followed by payment options and software upgrade, functionality, customisation and implementation respectively of 0.6400 and 0.5500. 0.4000, 0.3500 and 0.3100 respectively. This confirms Aduamoah et al (2017), position that some computerised accounting software suppliers do hide this inherent expenditure from the company from the initial stage, only to emerge during the upgrade and maintenance period which comes as unbudgeted expenses to some buying companies. Vendor reputation follow next in importance in ranking which also confirms Alanbay, (2005) assertion that vendor reputation should always consist of market share, length of experience and the exhibition of previously successful implementation in other known client companies. The next in ranking is software upgrade and maintenance to enable the company to be abreast with international trade requirements and to also stand the competition. Aduamoah et al (2017) posits that users of ERP should clearly understand software's features and its capability after implementation of the newer version after upgrade. Implementation, functionality, and Easy customisation follows respectively in importance when selecting the best ERP supplier.

DISCUSSION

In order to select an optimal ERP supplier, ERP selection team should make sure that the package suits their business processing strategy. This is made possible by selecting the best team who are different from each other in the same field of business to enable critical and logical thinking before assigning a point to a decision making variable. As we mentioned

before in the study, there are six major mechanisms in the variables in selecting best-fit ERP supplier. After the data collection and analysis, by using MAUT method, we determined the minimum and maximum values pertaining to expert participants in the study (Table 4.2, 4.7, 4.12,). We then normalised the dataset to ensure linearity by applying the formulae for cost and benefits. We then computed the Marginal Utility Score (MUS) to determine the satisfaction of suppliers in relation to the six criteria identified.

We then again determine the expert criteria weight of each variable; expert importance in the grouping regarding each variable criterion; experts' importance in the group regarding each assessment variable in table (4.4a table 4.4b and table 4.4c); (Table 4.9a Table 4.9b and Table 4.9c) and (Table 4.15a Table 4.15b Table 4.15c). We then computed the Weighted Marginal Utility Score by multiplying each variable of a supplier by the importance of the expert weight in the decision making process. This is depicted in Table 4.16 Table 4.14 Table 4.10. We proceeded to compute the aggregated weight by multiplying the Importance in the grouping regarding each variable criterion in by criteria weight of each variable to derive table 4.18. Finally we calculated the aggregate expert 1to 3 importance in assessment of the variables to determine the ranking of the variables relating to each supplier in Table 4.18.

Thus, as we can see that the criteria of vendor reputation comes first when selecting ERP supplier in CBPCs. This is followed by payment options, software upgrade, functionality, easy customisation and implementation respectively as depicted in table 4.19 in bolds, The results means that if the ERP supplier has good reputation the rest of the variables will flow with high precision. The only variable to request is payment options from the ERP supplier. Among the five whoever gives a flexible payment options will need to be optimally selected. These criteria have been chosen by us, because we believe that can be used by CBPCs in ERP selection in Columbia as it has mostly been tested academically and scientifically, and the weights assigned fully rest on conditions in Columbia which has been scaled and embedded in the questionnaires that we got from 44 CNPCs in Columbia. It is possible for other researchers to get different results by giving different weights to the selection criteria and sub-criteria by doing the research in other countries or areas. Although the method used is the same, the results may differ.

CONCLUSIONS

In other to implement an ERP package successfully to improve business processing both in the short to long term; it is critically important to choose an ERP supplier hose package which can be aligned with the requirement needs of the company. The purpose of our research work is to conceptualize and explain the methodical way ERP suppliers are selected by CBCs by adopting the MAUT by addressing two level evaluation criteria system which was constructed for the study. MAUT was deeply exploited to ensure reliability when rolled out in real time. The criteria in the model includes Vendor credentials (VC), Financing option (FO), Upgrade/Maintenance (Up/Main), Functionality of ERP (Func), Easy Customisation (Cust), and Implementation (Impl). The survey results indicates that those CBPCs selected for the study considered ERP supplier reputation, Payment Options, Upgrade/maintenance,

Functionality of the ERP package Easy Customisation and Implementation and other criteria when selecting an ERP package provider. These results answer our research questions as to which mechanisms are used to select the most optimally the best ERP in CBPCs in Columbia. Different companies can adopt MAUT concept but different results may be obtained due to different points which may be assigned to the variables in the model. Other variables may be added or those in the model may be reviewed downwards to suit the customisation needs of company.

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