AN AHP ALGORITHM FOR AN EFFECTIVE ERP TYPE SELECTION BASED ON THE AFRICAN CONTEXT

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ABSTRACT
The Literature reports many studies on ERP implementation in many African countries and points out the difficulties faced by these countries in the sustainable management of the selected solution. The data in this domain reveals that most of the projects are abandoned in the early stages of their life cycle. Moreover, for ERP solutions that have been put in place, most of them are used with serious difficulties which usually pushed the organisation to abandon the system, and implement a legacy one that meets the requirements related to the human capital and financial constraints. The present paper contributes to the ERP literature within the African context by proposing a model for ERP type decision making. The model is based on the AHP (Analytic Hierarchy Process) method and use contextual dimensions to sustain the decision making related to what is the best suited ERP type for an African organisation.

KEYWORDS
ERP Systems, African Context, ERP Type, ERP Taxonomy, ERP Type Selection, AHP

1. INTRODUCTION

An ERP system is a "comprehensive packaged application software designed to integrate the core corporate activities of an organization" (Ragowsky & Somers, 2002). This system intends to manage all the organizational aspects. Its implementation can become a complex and very risky task, mainly because of its scope (Ahituv et al., 2002), its implementation time, and since its use is shaped by the social context in which it is implemented (Al-Debei & Al-Lozi, 2012). According to Ross and Vitale, ERP systems can contribute to the growth of an organisation and make it more reactive in a competitive environment (Ross & Vitale, 2000). A system like this becomes important in developing context, such as the one of Africa. With some advantages such as the improvement of internal processes, the cutting down on operating costs and the improvement of relations with customers, an ERP system can be very useful for the development of local organisations.

With the necessity to improve the world in which we live, Walsham (2002) demands for more contextual studies, this trend needs to be more accentuated in developing countries such as those from Africa. The Data in this domain reveals that most of the projects are abandoned in the early stages of their life cycle. Moreover, for ERP solutions that have been put in place, most of them are used with serious difficulties which usually push these countries to abandon the system for the implementation of another one that might meet their requirements related to the human capital and financial constraints. As an example, in the country of Cameroon, the government initiated the implementation of an SAP solution to manage its civil servants in 2012 but until now (January, 2017), nothing is working yet. Some authors believe that the project experiments a failure (Etoundi et al., 2016).

A recent literature review reports several cases of ERP implementation in Africa (Manga et al., 2016). This literature exhibits a high tendency for African organisations to prefer commercial ERP systems (such SAP R/3 and Oracle JD Edwards) in spite of their limited economical capabilities. The government of Cameroon is an example. A report made

by *Panorama consulting*[1] for the year of 2015 reveals that the implementation cost had an average of $4.5 million. This is approximately equivalent to 2.7 billion (XAF) in Cameroon. For an African country, where some critical problems remain unsolved in domains such as *health, education, food, electricity, access to drinkable water…* such an investment is pointless and do not contribute to the development of these countries, rather it increases the local poverty.

To tackle this state of facts, the present paper is looking for a better way to choose an ERP system in the African context. We focus on ERP types to reduce the complexity (the scope) related to the amount of existing ERP systems. Thus the main question is how to help African organisations to select the best ERP type knowing their context? This raised the need to identify the existing ERP types, to characterise the African context and to define a decision making model.

The decision making model defined is an algorithm that adapts the AHP (Analytic Hierarchy Process) method to this specific case. AHP is a famous method in Operational research (Ho et al., 2010) and it is more and more used in the ERP literature. An example is the famous study of Wei et al. (2005) in which this method was used for the choice of an ERP system. The model proposed in this study extends theirs in a way that it can be used to assess the category (type) needed for an ERP before choosing a specific system within this category.

The present study is mainly qualitative and the criteria (dimensions) used were identified by combining several methodologies such as a literature review (Manga et al., 2016), the content analysis (Elo & Kyngäs, 2008), and the deductive reasoning (Johnson-Laird, 1999) approach. This helped to induce a framework that characterise the African context and a taxonomy of the existing ERP types.

In the following, the first section presents a categorisation of ERP systems on types and their organisation within a taxonomy. Next, the framework of the African context derived from the analysis is presented. The third section presents our proposed algorithm for ERP type selection. In the fourth section, the algorithm is applied to the Cameroonian case which comes from the study of Etoundi et al. (2016). The study ends with a conclusion and some perspectives.

2. ERP TAXONOMY

In this section the goal is to define a taxonomy or a categorisation of ERP types. Before doing that, we firstly identified them. We've combined several surveys from professionals, mainly consultants (Panorama Consulting, ERP focus[2], Gartner group), with surveys obtained in the academic literature (such as the one of Huang & Yasuda, 2016). This first step helped us to identify some terms used to characterise different ERP type. From that, several terms were reported, such as: *off-the-shelf ERP, on premise ERP, commercial ERP, Open-source ERP, Mobile ERP, Cloud ERP, In-house ERP, Outsourcing ERP, In-sourcing ERP and proprietary ERP*. It might be difficult to vouch for the completeness of these terms, but with the help of the exhaustive review made, it is hoped that these terms are the most frequent. All these names are used in practice, but with a woolly meaning, and we expect here to clarify that meaning.

After the identification, each term is studied and the global sense behind it is revealed to establish categories and thus deduce a taxonomy. Also, their importance and impact are less known from the academic literature. It's globally accepted that select the right ERP system can positively contribute to the ERP implementation success, but we believe that select the best suited type might increase the chances and reduce the complexity.

[1] http://panorama-consulting.com/resource-center/2015-erp-report/

[2] See http://erpfocus.com (Edition of 2016)

2.1. Open Source ERP

Open source ERP systems such as every open solution avoids vendor lock-in and promises to be good alternatives to proprietary solutions in term of organisational requirements fulfilment, package quality and implementation capabilities (Benlian & Hess, 2011). Open source solutions can be community or sponsored based solutions (Olson et al., 2015), they might be less expensive because of the absence of licence fees but demand for other material and support investments. Still, this type lacks of compliance with industry standards, documentation, maintenance, product updating, and responsibility (Olson et al., 2015). Hence, adopt this type in the African context might be at risk related to international standards.

2.2. Proprietary ERP

Proprietary ERP introduces the notion of ownership of a system by an organisation. The latter can be a provider of the solution or an organisation (a non-provider) who preferred to develop its own ERP to meet its requirements rather than to adopt an off-the-shelf one.

Giachetti (2010; p. 127) sees the notion of proprietary on the view of a non-provider organisation. For this author, the main advantage of this solution is that it meets the project requirements. Meanwhile, this approach is limited because of several risks such as the amount of time taken to develop and implement the system, and the probable future problems related to integration and maintenance (ibid). Olsen and Sætre (2007) share a similar vision. The author stated that this type of system can be developed by the organisation or by a third party for the organisation. This increases the control of the software, makes it flexible and dynamic to conform to the customers' needs, and thus strengthen the organization's competitiveness (ibid).

On the contrary, other authors see the notion of proprietary from the view of the provider to thwart for example the notion of community or open source ERP (Johansson & Sudzina, 2008). This type of solution comes from a unique provider (Serrano & Sarriei, 2006), thus it is associated with intellectual property rights (Olson et al., 2015), and can be adopted by small and medium sized enterprises to prevent cost and time constraints (Lee et al., 2011) necessary to develop a new system.

2.3. In-House ERP

The term in-house is used for cases were the ERP system is developed for a specific organisation, to fulfil its needs and requirements (Khaleel et al., 2016). Unlike the generic systems, which already exist before the adoption, in-house ERP systems enhance the global implementation time and cost. Adding to that, the time such as the cost needed for the development process are also high (Khaleel et al., 2016). One advantage to an in-house ERP is rather trying to change the way the organisation is doing business, it is used to extend the actual state by integrating legacy systems with several improvements of parts were new functionalities are needed (Olsen & Sætre, 2007). This type of ERP has a great chance to be accepted because of it fits with the social context and the users' preferences (Olsen & Sætre, 2007).

2.4. Outsourcing ERP

Outsourcing intervenes when an organisation, to be more effective, transfer a function usually done within its own walls to another, outside who has enough expertise and resource to handle it (Giachetti, 2010; p. 217). This process is frequent within domains such as automotive and computer manufacturing, where several parts of a system can be manufactured elsewhere out of the company. Acting like that may help the organisation to be

more efficient by focusing on its main areas of competence. In the case of ERP systems, outsourcing can reduce the cost of the global system's acquisition, increase the performance and the profitability of the business **(**Beheshti, 2006).

Meanwhile, decide to outsource some parts of an ERP system is a difficult task. When an organisation chooses this way, it should be aware of the fact that, it becomes implicitly more and more dependent on the outsourcing solution provider and thus it has to be confident according to this provider (Kahraman et al., 2010). This type raises some security issues that need to be assessed prior to the choice.

2.5. Off-the-Shelf ERP

This type is reported to be a "generic software package designed to serve a variety of enterprise types" (Soffer et al., 2001), an example is SAP R/3. That means, rather to traditionally program the software, the adopters may use an existing one by just setting-on parameters (Brehm et al., 2001). Report to Brehm, this type of ERP is not intended to be changed or modified. Olsen and Sætre (2007) refer to that type as a standard ERP delivered by a unique provider. When it is purchased, it's called commercial off-the-shelf ERP (Giachetti, 2010).

The dream to have a generic system who solve all the integration problems of an organisation is enticing, but it's still just a dream (Davenport, 1998). Sometimes it could become necessary to customize the system to make it fit the organisations' needs, mainly for African organisations.

2.6. On-Premise ERP

The term "on premise ERP" is used by many technical reports such as the one of *Panorama consulting* which identified in its edition of 2015 that, this type was the most used with 56% of the global market[3]. According to Boza et al. (2015), the term on-premise is used to differentiate between the localizations. The system can be lodged within the organisation (hence the term on-premise) or without (hosted). On-premise ERPs are referred to be more safe and reliable compare to the hosted ones, and are deployed within the adopting organisation's data centre (Lenart, 2011). Within the organisation, they are mostly accessed via a web browser and based on a client-server architecture. They are usually referred to "traditional ERP system" (Al-Ghofaili & Al-Mashari, 2014) because they represent an "old fashion". Many Editors such as SAP, Oracle and SAGE use this architecture. This type of ERP asks for in-house skills which might be a hindrance for African organisations.

2.7. Mobile ERP

The concept of mobile ERP was introduced to enable more mobility while using ERP systems. Mobile ERPs are based on web-based mobile cloud computing technology, which is composed of applications that use mobile broadband technologies such as the General packet radio service (GPRS), Universal Mobile Telecommunications System (UMTS), High-Speed Downlink Packet Access (HSDPA) and High-Speed Uplink Packet Access (HSUPA) (Cailean & Sharifi, 2014). According to Bahssas et al. (2015), this type of ERP has a lot of advantages; it contributes to the improvement of the quality of service, and the reach of greater productivity. It helps to enlarge business relationship and customer engagement, to increase the competitive advantage and the accessibility. Considering the high rate of smartphone use in Africa (Imran et al., 2016), a mobile ERP system can be of value and well accepted in this context.

[3] http://panorama-consulting.com/resource-center/2015-erp-report/

2.8. Cloud ERP

Cloud computing "is a network based service model that enables on demand network access to a shared pool of configurable computing resources such as servers…" (Bahssas et al., 2015). Cloud computing is intended to offer On-demand self-service, Broad network access, Resource pooling, Rapid elasticity and Measured Service (Dillon et al., 2010). It delivers several services usually accessed in-house or via the network, such as servers, storage or software.

Cloud ERP is a recent solution derived from the combination of cloud computing and ERP systems. It is hosted within the cloud, and is accessed by using cloud computing technologies such as Iaas & Saas (Infrastructure and Software as a Service). The cloud ERP comes with several advantages that can be useful for African organisations such as less staff, more mobility, easy expandability, cost reduction, and fewer expenses (Bahssas et al., 2015). Besides, the cloud ERP presents some challenges such as "security, flexibility, integrity of the provider and ability to move to another provider" (Lenart, 2011). A cloud ERP model includes several promises such as the reduction of the implementation cost (hardware and licence) and the implementation period (Zhong & Rohde, 2014).

A popular type of ERP using the technologies of the Cloud is the Saas with 33% of the market in 2015 according to PANORAMA consulting. Saas ERPs are reported to be much cheaper than their on-premise counterpart, but are less adapted for niche organisations (Faasen et al., 2013). The cloud ERP increases scalability and manageability, but don't have to be confused with Saas ERP. The two are not the same (Lenart, 2011): Cloud provides the necessary infrastructure to run Saas solutions.

2.9. Synthesis

The taxonomy derived from this literature can be found in figure 1. Based on the analysis of each term identified, four main categories are induced, in which each type can be ranged: *The ownership strategy, the implementation strategy, the deployment strategy and the architectural model*.

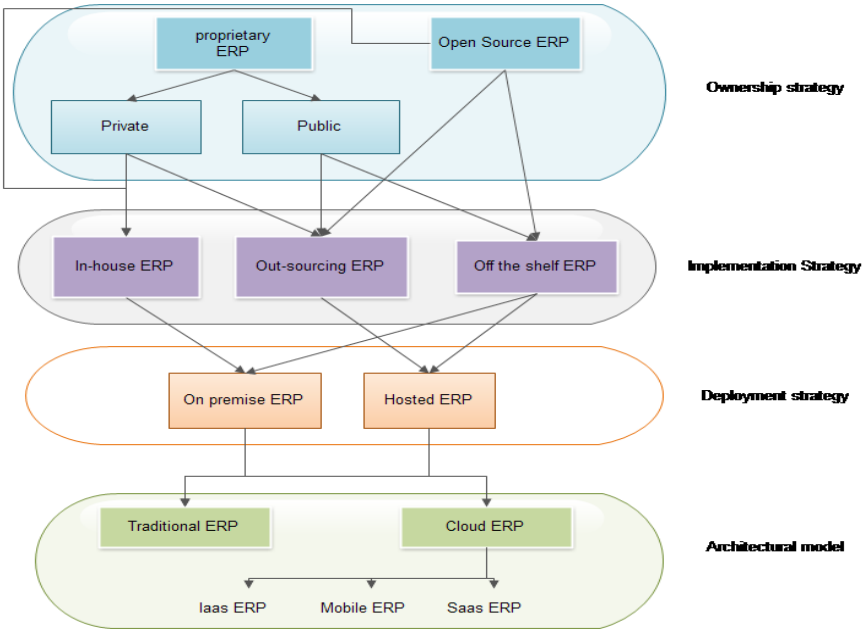

Figure 1: ERP Type Taxonomy

2.9.1. The Ownership Strategy

It represents the will of the organisation to possess a system or to adopt an existing one. The latter one can be delivered by a community or another independent company. Hence, to

clarify the distinction between the two types of proprietary, the notion of "private" and "public" is introduced. The "private proprietary ERP" will represent the case where the client organisation prefers to own the system and the "public proprietary ERP" will be used for systems provided by an organisation for a global market. In this way, an ERP system can be a community ERP (also called open source) or a proprietary ERP. In the last case, it can be private or public. The choice of one strategy as to be considered according to the capacities of the client organisation.

If the organisation decides to opt for a private proprietary ERP, it should make sure that several requirements are met: the needed human skills in technology development and the infrastructure should be present, the time has to be well managed to not impact the rest of the company's operations...

Otherwise, if the organisation prefers an existing system, whether it is open source or public, some requirements are maintained but with several differences.

For an open source, there will still be needs for human skills, infrastructure and time. Meanwhile, the time might become less important than by developing a new system.

For a public proprietary ERPs, Technical human skills are not mainly necessary because most of the ERP providers come with their expert. However, the implementation time will remain consequent as well as the needed infrastructure.

2.9.2. The Implementation Strategy

This category is composed of types such as *in-house, out-sourced, off-the-shelf ERP*. The generic system (off-the-shelf ERP), the tailored system (in-house ERP) and the hybrid system (out-sourced ERP) can be referred to as how the organisation prefers to implement the ERP type. In other words, they represent the type of implementation. An **off-the-shelf** ERP implementation strategy mainly concerns organisations that are willing to accept the system like it is. This type involves important BPR and is adapted for organisation with users that easily adapt to the novelty. **In-house** ERP implementation is mainly suited for healthy organisations with enough of human skills and infrastructures, and that share a culture of ownership. An **Out-sourced** implementation strategy can be well suited for less healthy organisations. Such as PME.

2.9.3. The Deployment Strategy

It represents the will of the organisation depending on whether it prefers to install the ERP system within its wall or externally. Hence, we talk about on-premise and (externally) hosted ERP. On-premise means "locally hosted", thus, an organisation with sufficient resources can decide to build a private cloud architecture located in its building. The deployment strategy comes with an architectural model.

2.9.4. The Architectural Model

Globally, at this point, two main types of ERP were found: Traditional ERP (web-based/client-server) and cloud computing based ERP systems. The cloud ERP includes Mobile, Saas and Iaas. Cloud ERP systems have the ability to be locally controlled or deployed, in that case, we talk about private cloud (Elragal & Kommos, 2012) which can be classified in the on premise category. This type is most suited for an important organisation with considerable resources. There are also public cloud ERP systems (The most present), which demands for less infrastructural and knowledge investment and can be categorised within the Hosted category. Because it is possible to deploy a generic ERP system within the organisation, we established a link between the off-the-shelf type and the on premise deployment strategy.

This section helped to deduce a taxonomy of ERP types based on the papers identified in the literature and the content analysis made. Report to this taxonomy, the view of ERP system as a generic system provided by a unique organism might need to be modified or extended. An ERP system can also be *private*, developed in-house for a particular organisation. The goal might now be to know how to uniquely or formally characterise an ERP system? Such a characterisation can be useful to assess the result of an in-house ERP development process for example.

After the typology, the next section focuses on the definition of a model that will be used to characterise the African context.

3. A FRAMEWORK FOR THE AFRICAN CONTEXT

Before starting an ERP project, it's important to be aware of the context in which the system will be implemented. In this section, the focus is made on the African context seen in its global sense. The goal here is to define a framework composed of several dimensions which can be used to describe a particular state in African countries. These characteristics were deduced based on the references from the review of Manga et al. (2016), combined with an extended analysis of other articles from the African literature. Hence, we found that African countries are characterised by *low economical capacities, the lack of infrastructures, a different cultural context, particular government policies and regulations, the lack of ERP experience and maturity, and limited human skills*. In the following, we present the identified dimensions and we synthetize them within a framework.

3.1. The Economical Aspect

One frequent dimension is the economic one. Most of African countries are below the level of upper middle income, which means their Gross National income per capita is lower than $12,746. Hence, most of the African countries are at least under the category of "Developing country" (DC). This means that the economic context of African organisations in general is low (Al-Debei & Al-Lozi, 2012), so any ERP adoption project should consider this state of facts.

The Economical aspect always calls for the problem of TCO (Total Cost of Ownership), the more it's important the less are the chances of the system to be adopted. An ERP project investment in general is costly without any kind of assurance associated with the outcome or the ROI (Return On Investment). According to Rajapakse and Seddon (2005), the TCO integrates *the cost of the package (the licence), of material, of consultation, of training, of maintenance and update*. Haddara (2012) adds to that other costs related *to vendor's services, Business Process Reengineering (BPR), machinery, human resource, change management, quality assurance*… Thus, for an African organisation, it might become very risky to undertake such a process.

It's widely accepted in the literature that the economic problem is critical in the African context while adopting ERP systems (Bailey et al., 2015; Huang & Palvia, 2001). Hence, the best ERP type for African countries which take the economical context into consideration should demand less investment and warrant good result related to the ROI.

The temporal aspect is added to the economic factor because, we believe that the much longer is an implementation of a system, the lower accepted it will be by African organisations. Indeed, the time taken to implement an ERP might increase the TCO with hidden costs for example.

3.2. The Infrastructural Aspect

The Infrastructural hindrance was identified in many studies (Bailey et al., 2015). In this study, the infrastructural scope of ERP projects is limited to IT infrastructure. IT

infrastructure needed for an ERP project in general are *network infrastructures, server platforms, database management systems, client platforms and Web technologies* (Chan, 1999). All these infrastructures and others that might have not been mentioned here, increase the TCO. Also, because it might be possible to lack certain infrastructure within the local market, other costs will be added related to the transfer of the needed equipment. All that might become very difficult for an African organisation. So, a good solution at this point might be the one with less demand on infrastructure investments.

3.3. The Cultural Aspect

African countries are characterised by a different culture in relation to developed countries. For example, considering the dimension of Power Distance, which contributes to explain how people collaborate to attain their objectives, Africans are rated high (Hofstede, 1993). It means that they accept the inequality of power distribution. This attitude could become a potential drawback on the management of African countries as stated by Boersma and Kingma (2005).

Also, report to Rajapakse and Seddon (2005), Africans have low individualism. One reason, according to the authors is that, they seem to be loyal with social groupings, convenient with low salaries and less committed to work.

There is an important cultural gap between the systems and African organisation. This may explain the resistance to change in the African context. According to that, the development of models that focus on African's culture is needed, rather than to adhere on an ERP cultural paradigm which is mostly from the western context (Giachetti, 2010; p. 372). The cultural aspect has to be considered when talking about the link between ERP and the organisational environment. So each future ERP design should embed the culture of the targeted organisation.

Another aspect that is not so often presented in the ERP literature is the corruption. This aspect is very important, mainly in the African context where most of the countries have a high corruption perception index according to Transparency International 2016[4]. This aspect is certainly present in ERP projects implemented in the African context and its impact on the whole project demands for more investigations.

3.4. Government Policies and Regulations

Information Technology (IT) adoption and diffusion within a country is particularly sustained by the will of its government (Huang & Palvia, 2001). This can be done with the definition of regulations that encourage or limit IT or ERP adoption. Hence, report to the authors, there is less engagement by the government, according to IT adoption in Developing Countries. As an example, in Cameroon, local IT organisations suffer to emerge because they are not sufficiently encouraged by the government. Most of the IT projects from the government or other big local companies, are externalized to Europe, despite the capability that local organisations might have to handle them. This externalisation has an impact on the economy of local emerging companies, and thus increases the local unemployment.

3.5. Human Skills and Experience

African countries are also characterised by limited experiences and maturity on ERP projects, and limited human skills (Al-Debei & Al-Lozi, 2012). The lack of Human skills and ERP experience might come from the difficulties that African peoples have to access to a good and cheap training or IT training centre. Most of the trainings are too expensive for local peoples. Also, the training procured is not always mastered by the trainers and centres lack of actual

[4] https://transparency-france.org/project/indice-de-perception-de-la-corruption-2016/

infrastructures useful for a practical training. African countries are poor and need for their development the existence of "real" partnerships between ERP providers' training centres and local centres or Universities. Local people need to be well trained on the mastering of the technology and its use. This can contribute to the sustainability of the local IT development.

Another aspect related to Human skill that can contribute to the sustainability of local development is the "self-production". Local engineers and scientists have the knowledge of computer science but lack of "know how" related to systems like ERP. This state of facts can be gradually shrink by good policies and regulations that encourage this self-development. A good example can be taken in India. African organisations should look at this way.

All the dimensions identified helped to define a framework that can be used to characterise the African context. This framework is represented in the figure 2. The African context, hence defined, the next section focuses on the definition of an algorithm for the decision making related to the best ERP type for an African organisation.

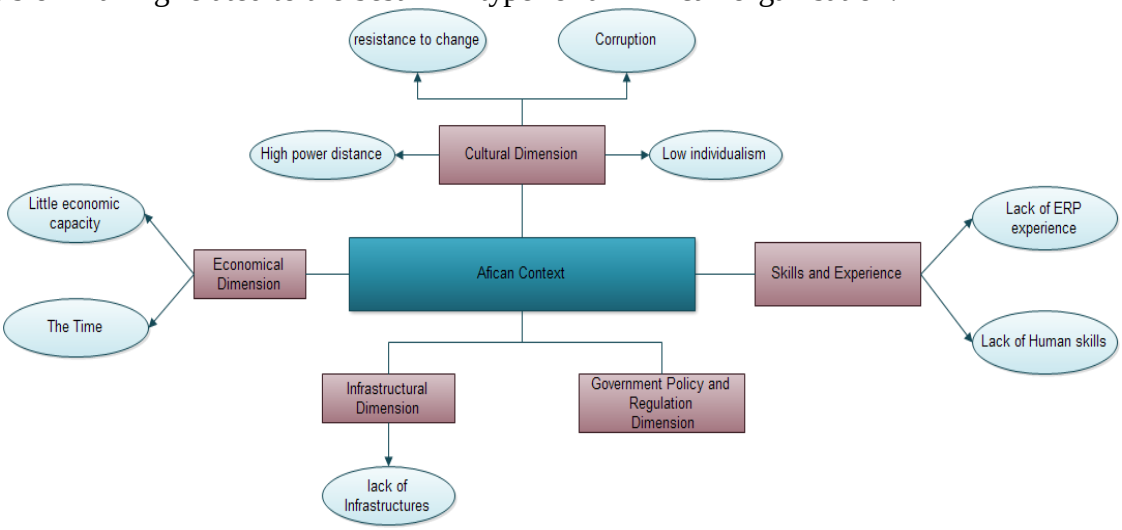

Figure 2: The African Context Framework

4. AN ALGORITHM FOR ERP TYPE SELECTION

This section presents an algorithm for ERP type selection within the context of Africa. This algorithm is an implementation of the AHP technique adapted to this specific decision problem. Before starting, we firstly recall the principle of the AHP approach.

4.1. The AHP Decision Making Method: Principle

Such as most of the MCDM (Multy Criteria Decision Making) Methods, AHP follows a principle based on (1) the existence of alternatives and criteria, (2) the study of the importance of each criterion as well as the impact of each alternative on this criterion, and (3) a ranking of each alternatives to identify the best one. Alternatives represent the possibilities of the decision maker and criteria represent decision constraints.

The global process derived from a mixture of the processes defined by Winston (2004), and Triantaphyllou (2000), is as follows:

- Two sets of alternatives and criteria are defined
- A pairwise comparison matrix is used to deduce weights of each criterion based on its importance according to the others. The matrix's values mainly depend on the decision makers' point of view. The importance is measured on an integer-valued 1-9 scale and depends on the subjectivity of the decision maker.
- For each objective or criterion, a score is given to each alternative. This score represents the degree of importance that an alternative might have on a criterion.
- Finally, we have a *m***n* matrix, where *m* represents the alternative and *n*, the criterion.

- The best alternative A^*, depending if we are looking for a maximization or a minimisation, is computed by using the following formula (Triantaphyllou, 2000) for the case of maximization:

$$A^* = \max_i \sum_{j=1}^{n} a_{ij} w_j, for\ i = 1, 2, \dots, m. \quad (1)$$

A^* represents the best alternative to the decision maker, a_{ij} is a weight. It represents the degree of importance of an alternative A_i on a criterion C_j. w_j refers to the weight of the criterion C_j.

4.2. An Algorithm for Our Decision Making Problem

Our problem consists of the selection of the appropriate ERP type based on the African context. Hence, the selection criterion are considered here to be the Framework's dimensions. Let's note **C** the set of all criteria, **C= {Eco, Cult, Skil, Infra, Gov}**. **Eco** represents the economical dimension, **Cult** = the culture, **Skil** = Skill and ERP Experience, **Infra** = Infrastructure, **Gov** = Government regulations and policies. These five criteria are used to assess the impact of the ERP type at each level of the taxonomy. Thus the decision needs to be made at each level of the taxonomy: the ownership strategy (**Own)**, the implementation strategy (**Imp**), the deployment strategy (**Dep**), and the architectural model (**Arc**). So the goal of the decision making model will be to suggest an alternative A^*_{lev}, at each one of the four levels. The figure 3 presents the AHP hierarchy model of this decision problem.

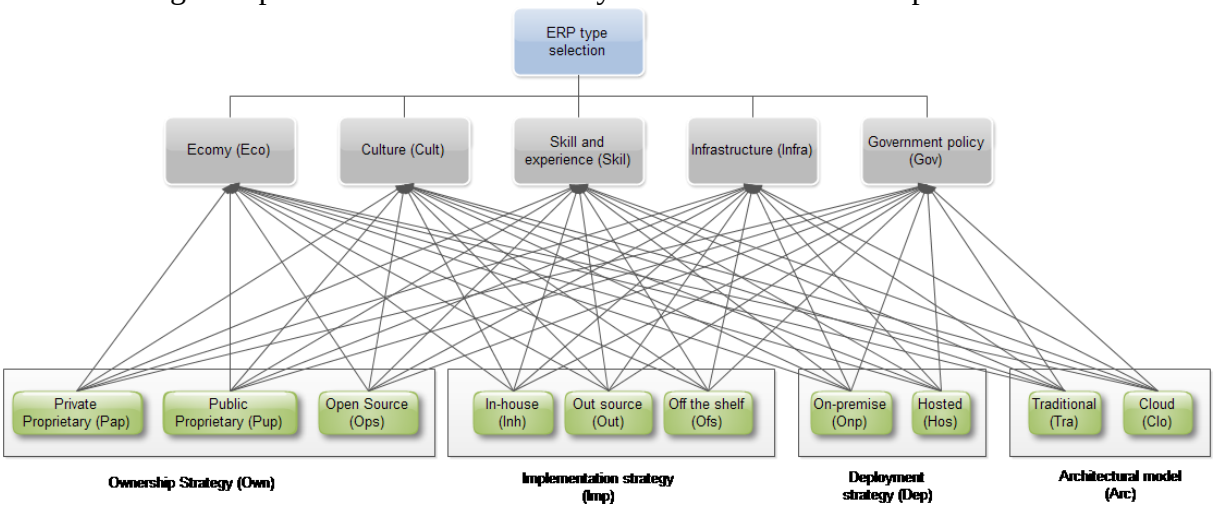

Figure 3: AHP Hierarchy Model of the Problem

Let's note **L** the set of levels, **L= {Own, Imp, Dep, Arc}**. Each level has a number of alternatives: **Own = {Pap, Pup, Ops}** (Pap = Private Proprietary, PuP = Public Proprietary, OpS = Open Source); **Imp = {Inh, Out, Ofs}** (Inh = In-house, Out = Outsourcing, Ofs = Off-the-shelf); **Dep = {Onp, Hos}** (Onp = On-premise, Hos = Hosted); **Arc = {Tra, Clo}** (Tra = Traditional, Clo = Cloud). The goal of this algorithm will be to construct four matrixes, one for each level, such as presented by the Figure 4.

Own Level

A_{Own}	Eco (w1)	Cult (w2)	Skil (w3)	Infra (w4)	Gov (w5)
Pap	a_{11}	a_{12}	a_{13}	a_{14}	a_{15}
Pup	a_{21}	a_{22}	a_{23}	a_{24}	a_{25}
Ops	a_{31}	a_{32}	a_{33}	a_{34}	a_{35}

Imp Level

A_{Imp}	Eco (w1)	Cult (w2)	Skil (w3)	Infra (w4)	Gov (w5)
Inh	a_{11}	a_{12}	a_{13}	a_{14}	a_{15}
Out	a_{21}	a_{22}	a_{23}	a_{24}	a_{25}
Ofs	a_{31}	a_{32}	a_{33}	a_{34}	a_{35}

Dep Level

A_{Dep}	Eco (w1)	Cult (w2)	Skil (w3)	Infra (w4)	Gov (w5)
Onp	a_{11}	a_{12}	a_{13}	a_{14}	a_{15}
Hos	a_{21}	a_{22}	a_{23}	a_{24}	a_{25}

Arc Level

A_{Arc}	Eco (w1)	Cult (w2)	Skil (w3)	Infra (w4)	Gov (w5)
Tra	a_{11}	a_{12}	a_{13}	a_{14}	a_{15}
Clo	a_{21}	a_{22}	a_{23}	a_{24}	a_{25}

Figure 4: The Resulted Matrixes

Based on the matrixes for the figure 4, the AHP formula will be applied to identify the best solution in each case. It is important to recall that in this problem, the best solution is the one with the least impact on the identified dimensions. Thus, by applying the equation **(1)** to each case, the final formula becomes:

$$\boldsymbol{for\ i = 1, 2, \dots, m\ with\ n = 5\ and\ m\ is\ a\ variable;}$$

$$\boldsymbol{A^*_{Own} = \max_i \sum_{j=1}^{n} a_{ij}w_j,\ A^*_{Imp} = \max_i \sum_{j=1}^{n} a_{ij}w_j,\ A^*_{Dep} = \max_i \sum_{j=1}^{n} a_{ij}w_j,}$$

$$\boldsymbol{A^*_{Arc} = \max_i \sum_{j=1}^{n} a_{ij}w_j,\ (2)}$$

$\boldsymbol{a_{ij}}$ is a **score** (also seen as the **weight**) that represents the impact of a type $\boldsymbol{t_i}$ on a criterion $\boldsymbol{C_j}$ **(**In other words, it represents how important is the impact of this type on the specified dimension). $\boldsymbol{W_j}$ represents the weight of the criterion **j** (in other words, it represents the importance of the dimension considering the context). $\boldsymbol{A^*_l}$ is the best solution within this level.

The derived algorithm, composed of three steps is as follows (For more details on how to compute each step, please refer to the book of Winston (2004, p. 789-795):

- **Step 1:** Construct a pairwise comparison matrix $\boldsymbol{M_C}$ for the set of criteria **C**
- **Step 2:** Construct the vector $\boldsymbol{W_C}$**=** [w1, w2, w3, w4, w5], based on **C** (It's supposed that the decision maker is inconsistent)
- Compute and evaluate the **CI** (Consistency Index)
- **Step 3:** $\forall \boldsymbol{l_j} \in \boldsymbol{L}, j \in [1,4]$ (for each level)
- $\forall \boldsymbol{C_i} \in \boldsymbol{C}, i \in [1,5]$ (for each criterion)
  - Construct a pairwise comparison matrix $\boldsymbol{M_t}$ of the impact of each type $\boldsymbol{t} \in \boldsymbol{l_j}$ on $\boldsymbol{C_i}$
  - Construct the vector $\boldsymbol{W_t}$ which represents the impact of each ERP type $\boldsymbol{t} \in \boldsymbol{l_j}$ with respect to the criterion (the dimension) $\boldsymbol{C_i}$.
- Construct the matrix $\boldsymbol{M_{l_j}}$ of the level $\boldsymbol{l_j}$ on which the columns represent each $\boldsymbol{W_t}$ associated to its $\boldsymbol{C_i}$.
- For each $\boldsymbol{M_{l_j}}$, compute $\boldsymbol{A^*_{l_j}}$ by applying the formula of equation (2)

The result of this algorithm (the set of all the $\boldsymbol{A^*_{l_j}}$ obtained) is intended to be the best strategies in each level according to the decision maker definition of the pairwise matrix.

5. IMPLEMENTATION AND EVALUATION ON A CASE IN CAMEROON

The government of Cameroon initiated the implementation of an SAP ERP solution, called SIGIPES II (Etoundi et al., 2016) to manage its civil servants and their payroll. The project starts since 2012 and it seems like the government could probably experience a failure. The goal of this study is to verify if knowing the Cameroonian context, this solution is the best one. The algorithm defined is manually applied with the help of a spreadsheet.

Normally, the construction of pairwise matrixes are collected based on the decision maker subjectivity, in this study, the weights were collected based on the data collected from the study of Etoundi et al. (2016).

Step 1: Compute the pairwise comparison matrix of **C**: $\boldsymbol{M_C}$.

For that purpose, it is assumed that Gov > Cult > Eco > Infra > Skil is the ranking of the degree of importance that each dimension might have on each order.

Mc	**Eco**	**Cult**	**Skil**	**Infra**	**Gov**	**CI**
Eco	1.0000	0.5000	4.0000	2.0000	0.2500	0.011519
Cult	2.0000	1.0000	6.0000	4.0000	0.5000	**CI/RI**
Skil	0.2500	0.1667	1.0000	0.5000	0.1250	0.009599
Infra	0.5000	0.2500	2.0000	1.0000	0.1667	
Gov	4.0000	2.0000	8.0000	6.0000	1.0000	

Table 1: Pairwise Comparison of C

CI/RI is used to verify the degree of consistency of the matrix. It should be lower than 0.10 with 5 criteria for a satisfactory consistency (Winston, 2004). **CI** is the Consistency Index and **RI** the Random index.

Step 2: The Vector **W** is derived after normalizing the Table 1, and we obtained **W = [0.1436, 0.2681, 0.0441, 0.0759, 0.4684]**. In terms of consistency, **CI/RI = 0.009599 < 0.10** which conclude to a good level of consistency related to the weight defined in the table above.

Step 3: Computation of each Matrix

- **The Ownership Level**

Own level						
$\boldsymbol{A_{Own}}$	**Eco**	**Cult**	**Skil**	**Infra**	**Gov**	**Score**
Pap	0,2344	0,6530	0,1096	0,1722	0,5869	0,501516
Pup	0,0778	0,0960	0,3092	0,3500	0,0893	0,118923
Ops	0,6877	0,2510	0,5813	0,4778	0,3238	0,379561

So At this level, report to the above table, the ranking based on the score is $\boldsymbol{A^*_{Own}}$ = **Pap > Ops > Pup**

- **The Implementation Level**

Imp level						
$\boldsymbol{A_{Imp}}$	**Eco**	**Cult**	**Skil**	**Infra**	**Gov**	**Score**
Inh	0,1638	0,5949	0,1429	0,2416	0,5949	0,486246
Out	0,2973	0,2766	0,2857	0,5662	0,2766	0,301947
Ofs	0,5390	0,1285	0,5714	0,1922	0,1285	0,211807

At this level, report to the above table, the ranking based on the score is A^*_{Imp} = **Inh > Out > Ofs**

- **The Deployment Level**

Dep level						
A_{Dep}	**Eco**	**Cult**	**Skil**	**Infra**	**Gov**	**Score**
Onp	0,1667	0,7500	0,2000	0,1667	0,6667	0,558701
Hos	0,8333	0,2500	0,8000	0,8333	0,3333	0,441299

At this level, report to the above table, the ranking based on the score is A^*_{Dep} = **Onp > Hos**

- **Architectural level**

Arc level						
A_{Arc}	**Eco**	**Cult**	**Skil**	**Infra**	**Gov**	**Score**
Tra	0,2000	0,8000	0,1667	0,1667	0,7500	0,614451
Clo	0,8000	0,2000	0,8333	0,8333	0,2500	0,385549

At this level, report to the above table, the ranking based on the score is A^*_{Arc} = **Tra > Clo**

Interpretation

The observations of the results are as follows: At the Ownership level, the results promote the use of a **Pap (Private Proprietary ERP)** strategy. This choice was mainly influenced by the **Government** and the **cultural** dimensions which seem to be of importance while investigating such a project in this context. At the Implementation level, the results promote the use of an **Inh (In-house ERP)** strategy. This choice is also mainly influenced by the **Government** and the **cultural** dimensions. At the Deployment level, the **Onp (On-premise)** strategy seem to be the best one. At the Architectural level, the **Tra (Traditional)** client/server strategy seem to be the best one.

The results obtained compared to the decision made by the government to adopt an **SAP ERP**, are completely different. SAP is a **Pup** (Public proprietary) ERP type, and seems to be a bad choice according to the study made. This can be true because, since its start, the project is not working; the Cameroonian government had lost a lot of time and money (Etoundi et al., 2016) and it is not the end. We believe that if a formal and contextual assessment process was executed before the starting, things might have been be different. Thus, it's now clear that the choice of SAP was not objective and this subjectivity might be the source of many other problems.

6. DISCUSSIONS AND CONCLUSION

ERP systems have a positive effect on African organisations and African users' satisfactions (Bailey & Seymour, 2015). Also because, the development of each IT innovation should be aware of the context (Hawari & Heeks, 2010) this study answers to several important questions related to ERP systems and their implementation on the African context such as:

How to characterise the African context? For that, a new theoretical framework is proposed with some dimensions that can be used to attain that goal. This framework represent the main characteristics of the African context and can be used as foundation by both academicians and professionals for more IT developments or studies in this context.

What are the existing ERP types? This is answered with the taxonomy of the ERP types. This Taxonomy helps to clarify some biases concerning ERP types. A frequent one is that, ERP systems are characterised by a unique provider (Olsen & Sætre, 2007). It is clear

that this is not always the same, an example is the one of In-house ERP type. The taxonomy proposed has the potential to reduce the complexity of ERP choice. By testing the categories in the first place, the number possibilities is reduced and limited to the systems within one category. This can effectively reduce the time and cost needed for the ERP selection step.

How to help African organisations to select the best ERP type knowing their context? The study proposes a model based on AHP that African organisations can use to select an ERP type. An advantage of this model is that it can be implemented and thus applied automatically.

This study is the first of its type based on its focus. It theorises on the hypothesis that the complexity of the ERP choice can be significantly reduced with a well-established taxonomy. Both the framework and the taxonomy defined in this study can be used as premises to the definition of a model for the assessment of the "pre-implementation" phase. Identify the best type strategy based on the organisation's context before the selection or the self-development of an ERP system may reduce several risks, and can positively impact on the implementation success. This was shown by the evaluation made with the Cameroonian case study. Consequently, before the implementation phase, an organisation should decide on its ownership strategy, its implementation strategy, its deployment strategy and the architectural model that best suits to its needs.

Besides these contributions, there is a need of an intuitive tool that automates the decision making process. Apply the AHP manually reveals to be a hard work, not error-free and in practice, not all decision makers understand this method. So the next step of this study is the implementation of a practical tool that will sustain the decision maker while choosing for an ERP type.

Also, Comparison matrices in the AHP methodology are mainly defined subjectively. So the weight depends on the point of view of each decision maker. This state of facts is risky, since an ERP project needs for considerable investment. Hence the model proposed needs to be enhanced and becomes more formal and objective. A trend can be to collect contextual data automatically.

This paper used data from one case study, this can be seen as a limit. More case studies in the Cameroonian context and in Africa are needed to test the models proposed. This can help to have more insights for better validation and improvement.

The present paper suggest the use of a private proprietary (Pap) ERP system for this Cameroonian case. It was identified in this study that this choice was driven by contextual criteria such as government policy and culture. Also, a Pap is reported to increase the organisation's competitiveness (Olsen & Sætre, 2007). Meanwhile, because of the complexity of ERP systems, develop a Pap could be very risky because of the cost, the time, and other resource investments. In another perspective, implement an Open source ERP or subscribe to a cloud ERP could be less costly, yet raises some risks related to contextual government policies and culture's misfits (Beijsterveld et al., 2015). So, there is a need for a new ERP design that consider the five challenges (dimensions) of the African context, the perspective of a context-aware ERP system emerges at this point.

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