SCHOOL OF MANAGEMENT
BLEKINGE INSTITUTE OF TECHNOLOGY

A Study of Open Source ERP Systems

Vittorio Gianni Fougatsaro
790503 - xxxx

Prof. Klaus Solberg Søilen

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ABSTRACT

In today's world, IT is a source of differentiation from competitors. The tendency is to produce more, with as little cost as possible and be reactive to the continuously changing needs and requirements of internal as well as external customers. That is why flexibility, adaptability and cost cutting are main reasons that are pushing increasingly more companies to adopt Open Source Enterprise Resource Planning (ERP) systems. The main objectives of this research work are to investigate whether Open Source ERP systems can satisfy the needs of large organizations as well as Small to Medium Enterprises (SMEs). The thesis tries also to answer the question of whether Open Source ERP vendors offer adequate level of support to their clients. First, the background of the research work and the motivations behind it are laid out. Then, the aforementioned research hypotheses are presented. The concept of Open Source, its history and the advantages of Open Source ERP systems are presented. In order to verify the research hypotheses, a comprehensive review of the literature discussing the ERPs selection criteria of large organizations and SMEs is carried out. This review resulted in a set of dimensions that served to build the evaluation model. Another component of the evaluation is the "features" which were compiled by looking at the feature offering of the different ERP systems. This model served as a guiding principle when evaluating the chosen Open Source ERP systems. Three Open Source ERP systems were chosen to be evaluated, those are OpenERP, EpenBravo and Adempiere. The following answers to the research hypotheses were found: we can say that the chosen Open Source ERP systems offer an adequate level of support to their clients. Moreover, they are suitable for SMEs as they were found to be able to answer most if not all SMEs' needs identified in this thesis. However, the chosen Open Source ERPs presented limitations when it came to their use in large organizations: those limitations can be summarized to their scalability as there are still doubts about the ability of those systems to handle big volumes of users or requests, and their ability to be scaled in cluster-like modes. Another limitation impacting large organizations is the lack of support for multiple international accounting regulations which is critical for publicly traded organizations.

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CHAPTER 1 : INTRODUCTION

1.1 Background

In today's business world, companies are increasingly looking for flexibility, cost savings and efficiency in the business applications they acquire. The increased competition has driven companies to look for new ways to succeed and remain competitive. In this IT led business environment, staying on the cutting edge of new technology acts as an enabler for companies to gain effectiveness and efficiency to face the competition. Enterprise Resource Planning (ERP), which will be defined in more details in paragraph 2.1, is one of those technologies that are at the heart of the IT strategy of a company. Flexible ERPs bring adaptable processes that support diversification strategy and ensure quick responses to the continuously changing business needs. In addition Open Source ERP systems bring cost savings compared to proprietary ERP systems and this makes them to me more popular and increasingly solicited.

Proprietary ERP systems such as SAP and Oracle have long been leading the ERP industry, but new players have emerged and seem to offer similar capabilities as their more established competitors, and most importantly they are Open Source.

Major proprietary ERP vendors include: SAP, Oracle Applications, Microsoft Dynamics, the SAGE group, PeopleSoft, J.D.Edwards, Baan, SSA Global Technologies. Infor Global Solutions.

Early 2000s saw a major software vendor consolidation with PeopleSoft merging with J.D.Edwards in 2003, then Oracle acquiring PeopleSoft in December 2004. Infor Global Solutions acquired SSA Global Technologies in 2006 which had acquired Baan in 2003. SAP and Oracle Applications alone control about 40% of the ERP software market.

In the Open Source ERP software market, we find the following major players: Adempiere, Compiere, ERP5, GNU Enterprise, OpenERP, Openbravo, Opentaps, WebERP and BlueERP.

Open Source refers to any software or program whose source code is made available to other developers for use, modification and enhancement. Open Source doesn't mean only access to the source code, the distribution terms of Open Source Software must comply with several criteria related to distribution, derived works, integrity of the author's source code, distribution of license, and license terms among others. The Open Source business model relies on shifting the revenue stream from the product itself to the product auxiliaries such as support, training, documentation, etc.

Open Source Software adoption in large companies is considered to be a relatively recent movement. Open Source Software is gaining terrain in large organizations, some see it as just another development alternative; others see in it a strategic competitive advantage.

The use of Open Source has proved itself in companies of the developed world. A study carried out by Forrester research in September 2008 revealed that Open Source is used on average by 1 in every 5 companies in Europe and North America, and 22% of those companies have chosen a 100% Open Source model. The study revealed also that, in general, companies start by introducing Open Source through the use of Apache web server or an Open Source operating system such as GNU/Linux. Then, development tools and programming languages such as Eclipse, PHP and Perl usually follow. The third phase is usually adopting Open Source solutions for database management, such as MySQL and Postgresql.

When it comes to application areas, the study revealed that the major areas of applications where Open Source solutions are used are office applications such as OpenOffice and StarOffice (used by 62% of the Open Source companies surveyed) and messaging such as Open-Xchange (used by 50% of the companies surveyed). Where is ERP from all this? The study showed that Open Source ERP is used by 38% of the companies surveyed.

It is a well known fact that large companies still have a preference for proprietary ERPs to run and manage their business. This market of proprietary ERP has been dominated for a long time by major players such as Oracle, SAP, Microsoft, PeopleSoft and Sage. Those companies offer a variety of products. But these products are complex, bloated with features, and too expensive for most mid-size companies. And, many of the traditional mid-market software vendors have disappeared in the consolidation trend that this mature market has been witnessing for quite some time. Customers continue to pay maintenance fees to the new owners for proprietary products that receive little new investment, and moreover, they have very few options by not having access to the source code.

Evidences are showing that the big vendor dominated market of ERP applications is also ready to start leaning towards non proprietary technology. Flexibility, cost savings, vendor independence and efficiency have been driving companies away from proprietary technology to Open Source. Moreover, the mid-market ERP segment is not well served – small to mid-size enterprises (SMEs) simply cannot afford the expensive proprietary products that the aforementioned ERP giants put on the market.

SMEs are companies whose headcount or turnover falls below certain limits. This abbreviation is commonly used in the European Union and international organizations such as the World Trade Organization, the World Bank and the United Nations. The European Union definition of an SME is the following: “The category of micro, small and medium-sized enterprises (SMEs) is made up of enterprises which

employ fewer than 250 persons and which have an annual turnover not exceeding 50 million euro, and/or an annual balance sheet total not exceeding 43 million euro."

Traditionally, ERP systems were reserved to large organizations. SMEs couldn't afford or have access to them and they were obliged somehow to content themselves with some modest accounting and sales management softwares, and not with a real ERP capable of adapting to the management and production processes specific to each company. It became clear that there is room for Open Source ERP systems and Open Source ERP players. In recent years, open source ERP software companies, such as Compiere, Openbravo, and Open For Business, with mature offers and with radically different business models than those of proprietary ERP vendors, have emerged with hopes of changing the ERP software industry.

1.2 Objective of the Study and Research Hypotheses

Open Source ERP seems full of potential for high growth in the future. As companies are searching more and more for cutting costs and gaining competitive advantage, Open Source seems to be a good alternative to SMEs and some large organizations, but do Open Source ERP systems stand up to the challenge and did they become mature enough to be the backbone of serious businesses? I intend to focus my research on studying the Open Source ERP system arena and evaluating its situation as compared to the standards that the big players and the proprietary solutions have established. The objective of this study will be to evaluate the ability of Open Source ERP systems to answer large organizations' and SMEs' needs. The following hypotheses are identified:

1) Open Source ERP Vendors offer appropriate level of support for their systems
2) Today's Open Source ERP systems are suitable for SMEs
3) Today's Open Source ERP systems are suitable for large organizations

1.3 Methodology

This paragraph describes the methodology used to assess the chosen Open Source ERP systems. The intention from the beginning was to carry out the evaluation in the most objective way possible. The study is a mixture of theoretical and empirical research.

The theoretical research focuses on carrying out a comprehensive review of relevant academic work to be able to build the model that will be used as a basis for the empirical study i.e. the evaluation of the chosen Open Source ERP systems. The model includes the evaluation criteria to be referred to when considering assessing an Open Source ERP package to be used by an SME or a large organization. SMEs and large organizations may have different as well as common needs from an ERP. The reviewed literature focuses mainly on discussing ERP systems selection criteria of SMEs and large organizations. The literature review will aim to come up with a list of “dimensions” which represent one of the two components of the evaluation model. The other component is the “features” which were identified by looking at the feature offering of the ERP systems.

Once the theoretical study is completed, the model for evaluating the Open Source ERP systems is built based on the “dimensions” and “features” identified through the literature study and the study of the ERP systems themselves. The model serves as the guiding principal when examining the ERP systems and collecting the empirical data. The evaluation of the systems based on the “dimensions” is performed in a qualitative way, and was fed by searching the documentation published on the vendors’ websites and also by evaluating the systems themselves after downloading them and installing them.

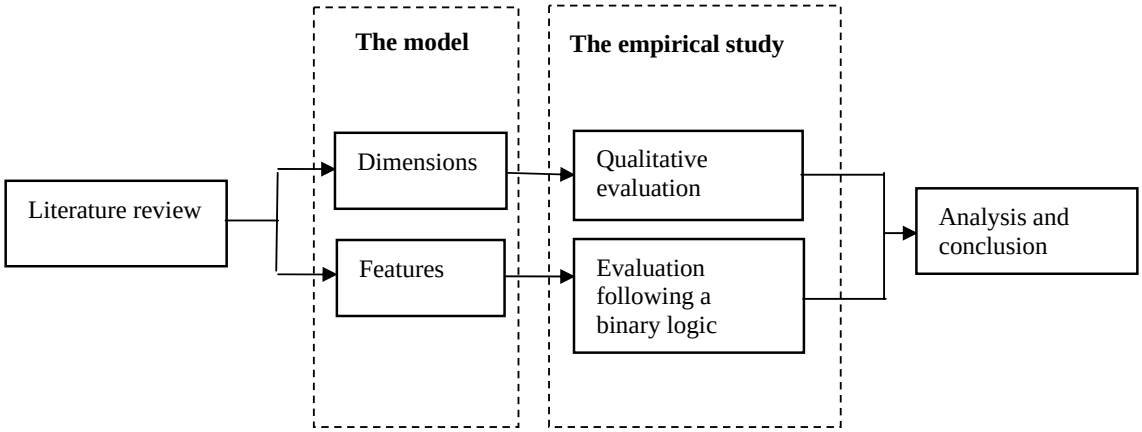

Figure 1.1: The methodology

1.4 Outline of the Thesis

The thesis report is organized in five chapters:

- Chapter one provides a background of the area of research and the motivations behind choosing this subject, and introduces the list of research questions that will lead the study as well as the methodology that was followed to carry out this research.
- Chapter two gives a comprehensive introduction of the area of study, defining ERP systems, their history, and the critical success factors for their implementation. This chapter talks as well about the concept of Open Source, its history and the advantages of an Open Source ERP system.
- Chapter three carries out a comprehensive review of the literature discussing the ERPs selection criteria of large organizations and SMEs. This review is the basis for building the evaluation model which is presented in chapter three and which will serve as a guiding principle when evaluating the chosen Open Source ERP systems.
- Chapter four presents the chosen Open Source ERP systems and the reason for choosing them. The bulk of chapter four is the empirical study containing the actual evaluation of the chosen Open Source ERP systems based on the model.

- Chapter five includes a final reflection on the chosen ERP systems and an analysis linking back to the result of the investigation to the research questions.

CHAPTER 2: ERP SYSTEMS AND OPEN SOURCE

2.1 Definition of ERP Systems

“An enterprise resource planning (ERP) system is an attempt to create an integrated product that manages the majority of operations in a company. What is different about ERP systems is that they integrate across functions to create a single, unified system rather than a group of separate, insular applications” (Alshawi, 2004). It is an integrated multi-module application software packages that are designed to serve and support multiple business functions and which treats those business functions as a cohesive whole, allowing data to be shared between different departments. This approach would help businesses and organizations alike to improve productivity and quality, and remain competitive. Typical functionalities include systems such as, accounting, human resources, customer order processing, purchasing, finance, inventory management, manufacturing/operations, distribution, planning, customer service, etc. Figure 2.1 gives an overview of an ERP system and its modules. ERP functions relate to effective Supply Chain Management, collaborative forecasting and planning, customer relationship management, product lifecycle management, e-procurement and e-business operations.

An ERP system helps an organization in integrating its key business operations. This integration improves the coordination between the different entities, streamlines workflows and processes and plays a key role in improving customer service and productivity and therefore bringing customer satisfaction. It helps as well in better

targeting customer needs, identifying prospects and better marketing the company's offerings. ERP systems also help bring visibility into the organization's operations and therefore they have a key role in enhancing management's decision making through the provision of real time and appropriate information, contributing to overall product quality, and effectively managing costs and inventories by better planning and forecasting of requirements. Although an ERP system is a pure software package, it embodies established ways of doing business. Studies have illustrated that an ERP system is not just a pure software package to be tailored to an organisation but an organizational infrastructure that affects how people work and that it imposes its own logic on a company's strategy, organization, and culture (Shehab et al., 2004).

Perhaps one of the most important parts of the ERP system is the central database. This database is used to store information from various modules. Those modules provide various forms of data from different departments within the organization, thus making integration the most important aspect of an ERP. Very often, companies use only some features or modules of an ERP system and they interface those modules with their own standalone systems or modules from other vendors. ERP software is a packaged software implying a high degree of being standard, and thus it very often gets customized to meet each companies specific needs.

Leading companies providing proprietary ERP systems include SAP, Oracle, Sage and Microsoft. ERP systems traditionally being used by large organizations are finding their way into SMEs which, however, often find it difficult to find the necessary resources and budget to accommodate a leading brand proprietary ERP system. Server and site licenses for ERP software traditionally are costly. ERP systems incur as well high installation costs. Open Source offers a compelling alternative in this area. Several arguments can backup this statement: Open Source ERP system offers an accessible and affordable curve of adoption. Companies can download the system for free, try it, evaluate it and run demos; They allow cost reduction, namely licensing costs; They also offer a certain flexibility that is more difficult to find in proprietary ERPs which can be highly inflexible and generic, requiring a great deal of customization for every implementation. A broad range of Open Source ERP

implementations are developed continually by the community on a project basis, with many customers sharing and learning skills along the way.

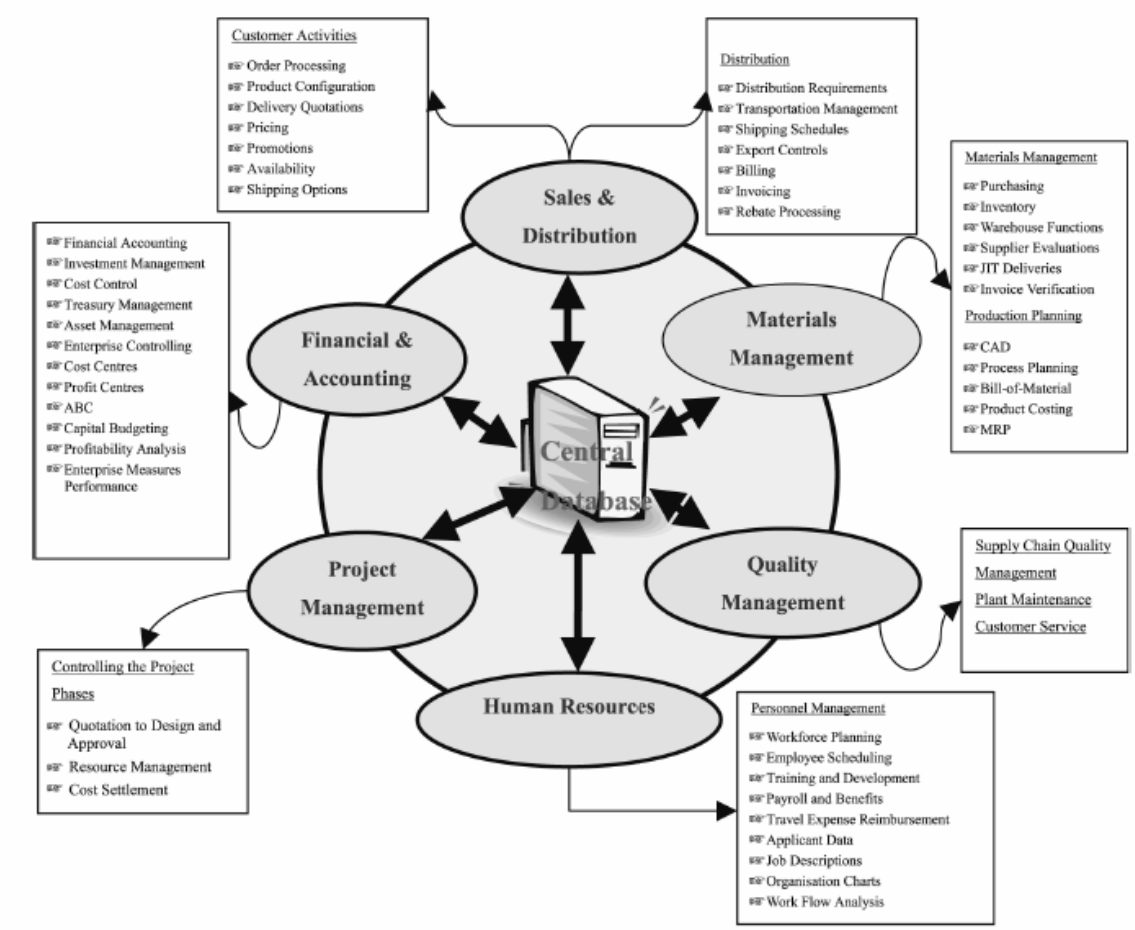

Figure 2.1: *an overview of typical ERP system modules (Shehab et al., 2004)*

2.2 History of ERP Systems

ERP systems are an evolution of MRPs (Manufacturing Resources Planning) which focused on planning activities in manufacturing firms. Prior to 1960s, the primary focus of systems was on inventory control based on traditional inventory concepts (Metaxiotis et al., 2003). The early 1960s witnessed early computers (mainframes)

and early MRPs known as MRP I. Material Requirements Planning (MRP) was the first off-the-shelf business application (Orlicky, 1975). “MRP software supported the creation and maintenance of material master data and bills-of-material across all products and parts in one or more plants” ((Metaxiotis et al., 2003). The 1970s witnessed the expansion of hardware, early PCs, some inclusion of accounting functions and an initial focus on business processes (Jacobs and Weston, 2007). This period saw as well the birth of big software vendors such as SAP, J.D. Edwards and Oracle with its widely known Structured Query Language (SQL). The 1980s saw the need to integrate the other resources of a manufacturing organization, hence the evolution of the concept of Manufacturing Resource Planning or MRP-II, with its closed loop business processes and which was an extension of MRP to shop floor and Distribution management activities. The 1990s saw a rapid growth in hardware as well as ERP systems with the focus on integrating business processes within and across business functions. MRP-II was further extended to cover areas like Engineering, Finance, Human Resources, Projects Management, product development and production processes i.e. the range of activities within any enterprise. Hence, the term ERP (Enterprise Resource Planning) was coined. ERP is a marriage of MRP II (Manufacturing Resource Planning) systems and client/server technologies. ERP includes more of the supply chain that MRP II to include planning and scheduling suppliers’s resources based on customers’ demands and schedules ERP gained popularity starting 1994 when SAP released its next generation software named R/3. in the following years, big amounts of money have been poured by companies into ERP systems developed by SAP and its competitors such as Oracle, Baan and J.D. Edwards. It can be said that ERP systems reached the maturity stage by mid 1990s (Shehab et al., 2004). The scope of the systems has expanded to include back-office functions such as order management, financial management, warehousing, distribution production, quality control, asset management and human resources management. In recent years, this scope has also extended to include front office functions such as sales force and marketing automation and electronic commerce (Shehab et al., 2004).

When it comes to technology evolution, early ERP systems worked with big mainframe computers. Recent ERP systems are based on client/server architecture

(Rao, 2000). In such a configuration, the server stores the data and processes the users' requests from the client's desktop (Shehab et al., 2004). The load of the data processing is shared between the server and the client (Gupta, 2000). Currently, the tendency in architecture is leaning towards a browser/Web server architecture in order to deliver e-business capabilities (Yen et al., 2002). In this architecture, the user interface is implemented using a graphical user interface (GUI) techniques and deployed on client machines; the server on the other side hosts the business logic and the databases built using relational database technology (Rao, 2000).

Early 2000s saw a major software vendor consolidation with PeopleSoft acquiring J.D.Edwards, Oracle acquiring PeopleSoft. Oracle and SAP were the major ERP vendors that survived. According to AMR, the number of ERP vendors went down from more than 100 in 1993 to about three dozen in 2005.

2.3 Critical Success Factors of ERP Systems Implementation

Even though the thesis is about studying and analyzing select Open Source ERP systems, a successful ERP implementation doesn't depend solely on the system itself or in other words the technical, it also depends on a set of critical success factors which are more or less related to the planning of the ERP implementation. Stories about ERP implementation failures are not rare. Dell Computers spent tens of millions of dollars on an ERP system, which was later found to be too rigid to suit Dell's expanding global operations; they were later forced to get rid of it and lose the money that was invested in implementing it. Other ERP failures examples include Boeing, Dow Chemical and Kellogg's (Chen, 2001).

Prerequisites or critical success factors (CSFs) of ERP systems implementation have been a widely discussed subject among researchers:

- From a culture point of view, Krumbholz and Maiden (2001) argue that organizational culture is one of the main factors associated with ERP

implementations failure or success, but national culture is not. During the implementation of an ERP, being aware of the stakeholders involved is critical.

- A careful planning of an ERP implementation strategy is needed to be able to deal with employees' resistance to change (Al-Mashari and Zairi, 1999).

Fui-Hoon Nah and Lee-Shang Lau (2001) identified 11 factors critical for ERP implementation success, by reviewing 10 articles that discuss CSFs of ERP implementation . Those are the following:

- *ERP teamwork and composition:*

  The team should be cross-functional with business and technical knowledge. Knowledge of the business functions and products is needed so that they know what needs to be done to support major business processes (Rosario, 2000). The team should as well have a mix of consultants and internal staff so that the internal staff can develop the necessary technical skills for design and implementation (Sumner, 1999). Information sharing and partnership trust within the organization and between the organization and its partnering companies is vital (Stefanou, 1999)

- *change management program and culture:*

  Companies, over time, establish their own culture, values, norms and habits. Any attempt for disturbing those habits is usually met with resistance. Change management efforts include a strong commitment from management to use the system for achieving business objectives (Roberts and Barrar, 1992), training users, regular communication, involving users in design and implementation of business processes and the ERP system so (Bingi et al., 1999), and creating the support organization (users manuals, help desk, to assist users after the implementation.

- *top management support:*

  Top management needs to stand behind the project by getting involved and allocating the necessary resources and publicly make the project a top priority (Wee, 2000).

- *business plan and vision:*

  A clear business plan outlining the tangible and strategic benefits, resources, costs, risks and timelines is essential (Wee, 2000)

- *business process reengineering with minimum customization:*

  According to Roberts and Barrar (1992), organizations should be willing to mold and align their business processes to fit the new system with minimal customization. It is recommended to change the software as little as possible to avoid errors and take advantage of new versions and releases (Rosario, 2000).

- *project management:*

  This includes setting a clearly defined scope (Rosario, 2000) for example the amount of modules to be implemented and the amount of process reengineering needed. It includes as well setting up milestones, coordinating training with the involvement of the Human Resources department, planning of tasks and accurate estimation of effort (Rosario, 2000), and a focus on results and tracking of schedules and budget against targets (Wee, 2000).

- *monitoring and evaluation of performance:*

  The project should be monitored through defined milestones and targets. Once implemented, early proof of success of the ERP implementation showing the positive impact of the new system on business performance needs to be provided to drive enthusiasm and encourage the use of it. Reports should then be regularly generated including a set of metrics designed to follow up the effect of ERP on business performance.

- *effective communication:*

  Communication involves telling employees in advance the scope, objectives, activities and updates (Sumner, 1999). It also includes getting and managing users' requirements, comments, reactions and approval (Rosario, 2000).

- *software development, testing and troubleshooting:*
  In the development stage, a choice has to be made regarding the approach to link the new ERP system to legacy systems. Sometimes, companies choose to integrate other specialized software products with the ERP suite to better meet business needs. Vigorous and comprehensive software testing eases up implementation (Rosario, 2000). Moreover, the company needs to work with vendors and consultants to troubleshoot the software and resolve the errors (Holland et al., 1999).

- *project champion:*
  There is the need to have a high level executive sponsor who drives the success of the project, set the goals, manage and legitimize the change (Falkowski et al., 1998).

- *appropriate business and IT legacy systems:*
  Holland et al. (1999) argue that existing business processes and IT systems, organization structure and culture have an impact on the success of ERP implementation and help determining the IT and organization change required for success.

Chen (2001) argues that there is a growing consensus that planning issues are the major barriers to employing theses systems effectively. Planning issues include needs assessment and choosing the right ERP system, matching business process with the ERP system, understanding new organizational requirements and the economic and strategic justification of ERP projects (Chen, 2001).

2.4 Definition and History of Open Source

In general, Open Source refers to any program or software whose source code and some other rights are made available for use or modification by others, under a software license that meets the Open Source definition of the Open Source Initiative (OSI) or that is in the public domain. Open source software is usually developed as a

public collaboration and made freely available. In summary, the Definition model of distribution terms requires that:

- The software being distributed must be redistributed to anyone else without any restriction
- The source code must be made available in readable form (so that the receiving party will be able to improve or modify
- Derived work must be allowed under the same license conditions.
- Integrity of the author's source code (licenses may require that modifications are redistributed only as patches).
- No discrimination against persons or groups.
- No discrimination against fields of endeavor.
- Distribution of license (license applies to all whom the program is redistributed to, closing up software is forbidden).
- License must not be specific to a product.
- License must not restrict other software.
- License must be technology neutral.

The movement towards Open Source started a long time before the term Open Source as we know it today started to be used. It can be said that in the beginning, there was only free software. Then came the proprietary software which dominated the market for a long time to the extent that it was considered by some as the only option. And recently, Open Source is back again to be considered as an option. In the 1950s and a little bit into the 1960s, most software was developed by academics and researchers working in collaboration and freely exchanging it among them. User groups such as that of the IBM 701, called SHARE, and that of Digital Equipment Corporation (DEC), called DECUS were formed to facilitate the exchange of software. Those groups developed much of the software that hardware companies bundled later on and made available through their hardware products.

In the 1960s, things started to change. The movement towards unbundling the software from the hardware started growing, especially after the US government charged IBM that bundled software is considered anticompetitive. This has led to a

growing amount of software emerging as for sale only. Despite this fact, one of the most noticeable collaborative processes of the 1960s, the one regarding the development of telecommunication network protocols led to the birth of the Internet in 1969. In this first era, the sharing by programmers in different organizations of the source code was commonplace. These cooperative projects were undertaken on a highly informal basis. This informality proved to be problematic in the early 1980s, when AT&T started enforcing its intellectual property rights through restrictive licenses related to the operating system software UNIX.

In response to the threats against the free software exchange that were brought by AT&T, efforts emerged to formalize the ground rules behind the collaborative software development, announcing the beginning of the history of Open Source as most people know it today. In the early 1980s, two movements were setting up the roots of the Open Source movement: the first, led by Richard Stallman, a former programmer at MIT AI Lab, launched the GNU project and the Free Software Foundation, with the goal to develop and distribute a wide variety of software without a fee. A formal licensing procedure, the GNU General Public License (GPL) was designed to ensure that the software developed by GNU is free and to promote the production and distribution of free software. This kind of license is sometimes called “copyleft” as opposed to “copyright”. The terms of this license are distinct from “shareware,” where the binary files, but not the underlying source code, are made freely available. They are also distinct from public-domain software, where no restrictions are placed on users of the source code: the people who contribute to the public domain are not obliged to put the new product in the public domain.

The second movement is that of the Computer Science Research Group (CSRG) of the University of California at Berkeley. This group, with the help of Unix hackers around the world, was improving the Unix system which become ``BSD Unix''. In the late 1980s, this software was distributed under the ``BSD license'', one of the first open source licenses.

During the late 1980s and 1990s, Open Source saw a dramatic acceleration with the help of the internet. Transnational efforts came together to give birth to well

organized communities which in turn gave birth to several flagship Open Source software. Most notably, there were two projects that were being developed: the 386BSD developed by Bill Jolitz with the aim of making an unencumbered version of BSD Unix (free of AT&T copyrighted code). It made a complete operating system and it quickly became appreciated within the BSD and Unix communities. The work was covered by the BSD license. The other project taking place in Finland, where Linus Torvalds, was implementing the first versions of the Linux kernel. The collaboration of people around this project gave birth to GNU/Linux6, a real operating system. This work was covered by GPL. In 1993, both GNU/Linux and 386BSD were considered to be reasonably stable platforms. Since then, 386BSD has evolved into a family of BSD based operating systems (NetBSD, FreeBSD, and OpenBSD), while the Linux kernel is evolving and being used in many GNU/Linux distributions (Slackware, Debian, Red Hat, Suse, Mandrake, and many more). In the late 1990s, both got to the stage where they have become a real alternative to proprietary systems, competing with the market leaders (like Windows NT in servers).

Other flagship Open Source products that came out during the 1990s are: systems based on a common "stack" of software with the Linux kernel at the base, Apache (widely used as a Web server, with a market share consistently over 50%), the MySQL database engine for data storage, and the PHP programming language binding it all together, came to be known as LAMP systems. Other Open Source innovations included, Perl (an interpreted language with lots of libraries), Mozilla (the free software project funded by Netscape to build a WWW browser.Netscape licensed and released the code of its Netscape Navigator in January 1998 as open source under the Netscape Public License and subsequently under the Mozilla Public License) etc.

Netscape’s act prompted some people active in the free software movement to look into how to bring free software principles and advantages into the commercial software industry. They concluded that the social activism of the Free Software Foundation run by Richard Stallman was not appealing to big commercial companies were looking for rebranding the term free software and emphasizing its commercial and business potential. The term Open Source was born as an alternative and the

Open Source Initiative (OSI) was formed in February 1998, and the open Source Definition came soon after. The Open Source connotation was adopted by key people in the free software movement. One of the OSI goals was to preach the principles and commercial potential of Open Source and therefore they were seeking to bring major software and high tech companies into Open Source.

The act of Netscape prompted as well several big companies such as Apple, Corel and IBM, as well as small companies to understand Open Source and explore new business models to remain competitive in the software market. Some big software vendors became contributors to the Open Source projects. The following is not the exhaustive list of project that each of the companies that will be named contributed to: IBM (Eclipse, Sakai, SUSE Linux), Oracle (Berkeley's DB, Eclipse, Fusion Middleware, jDeveloper, PHP, Sakai) Novell (Apache, Eclipse, Jboss, Linux Kernel, Mozilla, MySQL, openLDAP, OpenOffice, Perl, PHP, PostgreSQL, Tomcat) SUN Microsystems (GNU/Linux, Java, OpenOffice, OpenSolaris, Sakai, Sun released as well a previously proprietary code base into the public domain e.g. SUN Microsystems' Java programming language).

2.5 Advantages of an Open Source ERP System

With an Open Source ERP we can expect savings related to license costs. However, these savings can become negligible when the integration and maintenance costs are taken into account (Valyi, 2008). Valyi (2008) argues that Open Source ERP costs are made visible and clear in a transparent way from the beginning of the integration process, while proprietary ERP vendors are good at hiding their costs on the long term. Many companies who chose to implement proprietary ERPs have experienced the additional costs over time and the swelling of their real price which can become double the original price. According to a study carried out by the Standish group (2000) discussing proprietary ERPs implementation, 28% of the implementations respect the budget, the time and while satisfying the needs of the enterprise, 49% are a failure in terms of budget, time and functionalities, and 23% are abandoned before they finish.

Beside the cost advantage, Open Source ERPs can bring an additional advantage by offering a better coverage of the needs of the business thanks to its scalability.

In a white paper released by Smile (a French company specialized in implementing Open Source solutions) in 2008, Valyi (2008) listed several advantages of Open Source ERPs:

- *Flexibility*: With Open Source ERPs, it is the source code itself which is made available for free and thus open for interfacing and integration with other systems. Moreover, customizing and integrating of the Open Source ERP with existing systems can become an easier task for the company to do it internally or to find external experts due to the availability of resources and documentation for free on the internet. Moreover, proprietary ERP vendors have the tendency to implement less number of standards, as this can prove costly to them. Therefore, they usually use their own protocols which are not valid outside the limits of the vendor itself. This results in what is called vendor lock-in.

- *Quality*: Valyi (2008) argues that Open Source ERPs are distinguished by a superior quality on the technical level. This superior quality can be the result of the commitment of Open Source ERP vendors to technical challenges.

- *Ability of adaptation to the business environment:* for proprietary ERP vendors, it is up to client to adapt its business processes to the ERP system in question, justifying this by the fact that they have implemented a better knowledge in the domain and that they have implemented the best practices in their products. Open Source ERP system offer the possibility to the client to adapt the system to its environment and business practices.

- *Infrastructure model that suits SMEs:* proprietary ERP systems have a costly infrastructure model that prohibits them sometimes from adapting to the economic reality of SMEs. Moreover, at the technical level, proprietary ERPs

incur high integration costs whichis not convenient for SMEs. Nowadays, several traditional proprietary ERP vendors are trying hard to attract the SMEs segment by offering new solutions with lower integration costs. An example of this is SAP's Business One. But according to Valyi (2008), those offerings remain limited.

- *No hidden costs*: many proprietary ERP vendors attract clients by proposing packages at acceptable prices but which soon turn out to be limited, namely by the number of users. Once an organization adopts a proprietary ERP package, it can find itself locked in a costly battle to scale up the system if the need arises to increase the number of the ERP users.

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

- *Vendor's independence:* by adopting an Open Source ERP, the client is not at the mercy of the vendor. The support of the product is provided by the "community" and the client is in a powerful position to exert a proactive pressure over the vendor.

- *Freedom for upgrade:* an organization that chose to adopt an Open Source ERP can choose to upgrade it whenever they want. They can choose to do the upgrade themselves or at the best price by sending several requests for proposal to several competing third parties and choosing the best offer at the end.

CHAPTER 3: THE MODEL FOR EVALUATING THE ERP SYSTEMS

A model needed to be identified and utilized as a basis for evaluating the Open Source ERP systems. The model is intended to include the evaluation criteria to be referred to when considering assessing an Open Source ERP package to be used by an SME or a large organization. SMEs and large organizations may have different as well as common needs from an ERP. The model is designed by carrying out a comprehensive literature review discussing ERP systems selection criteria of SMEs and large organizations, as well as by looking at the feature offering of the ERP systems.

3.1 Literature Review

Companies are usually triggered by the appearance of some symptoms to adopt ERP systems. Such symptoms can be high levels of inventory, mismatched stock, lack of coordinated activity, excessive need for reconciliation, flouting of controls, poor customer response levels, poor cost control, lack of efficiency and lack of a total visibility into the overall supply chain performance (Shehab et al., 2004). Shehab et al. (2004) argue that the ERP package selection process is deceptively difficult.

Several research studies have addressed this point: Hecht (1997) presents six major criteria for selection and evaluation process: functionality, technical architecture, cost, service and support, system reliability, and vision. Siriginidi (2000) argues that, from

a customer's point of view, key selection factors can include stability, support from the supplier, history of the ERP supplier, last year track record of ERP sales, and improvement in ERP packages. Another study was carried out by Bernroider and Koch (2001) among Austrian companies exploring the differences in ERP selection criteria between SMEs and large organizations. First of all, the study showed that there is a significant influence of the organizational size on the software package being selected. The study revealed that aspects related to flexibility that the ERP software is supposed to bring into the organization (e.g. increased organizational flexibility, process improvement and improved innovation capabilities) have been rated as less important by smaller organizations, as these tend to be flexible from the beginning. Another point that the study revealed is that adaptability and flexibility of the software is more highly valued by smaller organizations. A short implementation time and lower costs are also given more importance, as resources are a bigger issue. Internationality of the software and customer and supplier needs are given less importance. High importance has been attributed to fit with business procedures, flexibility, costs, user-friendliness of the system and short implementation time, by both large organizations and SMEs. This has also been corroborated in another empirical study of European midsize companies conducted by Everdingen et al. (2000). Figure 3.1 shows the results of the study by Bernroider and Koch (2001). In this latter study, it was reported that all the European mid-markets tend to focus on product characteristics such as the functionality and quality of the products and services, rather than on characteristics of the ERP supplier of the product. The speed of implementation, the possibilities of the product for interfacing with other applications and the price of products and services are also important selection criteria.

	Company size	Very important	Important	Rather unimportant	Irrelevant
Operating system independency	Small/medium	15.8	26.3	52.6	5.3
	Large	30.9	39.2	23.7	6.2
Process improvement	Small/medium	31.6	47.4	21.1	0.0
	Large	52.0	40.8	6.1	1.0
Market position of vendor	Small/medium	16.7	55.6	11.1	16.7
	Large	35.1	48.5	14.4	2.1
Customer and supplier needs	Small/medium	5.3	10.5	26.3	57.9
	Large	12.4	20.6	27.6	39.2
Internationality of software	Small/medium	31.6	10.5	26.3	31.6
	Large	37.8	30.6	19.4	12.2
Increased organizational flexibility	Small/medium	31.6	42.1	21.1	5.3
	Large	49.0	38.8	9.2	3.1
Increased customer satisfaction	Small/medium	26.3	42.1	26.3	5.3
	Large	45.4	35.1	14.4	5.2
Guidelines from a controlling company	Small/medium	10.5	21.1	10.5	57.9
	Large	24.2	18.9	15.8	41.1
[a]Adaptability and flexibility of software	Small/medium	68.4	26.3	5.3	0.0
	Large	49.5	44.3	5.2	1.0
Improved innovation capabilities	Small/medium	11.8	29.4	52.9	5.9
	Large	20.6	40.2	29.9	9.3
[a]Short implementation time	Small/medium	36.8	57.9	5.3	0.0
	Large	29.9	51.5	13.4	5.2
Good support	Small/medium	42.1	57.9	0.0	0.0
	Large	58.8	37.1	4.1	0.0

Notes:
All given values are percentages
Table sorted by the absolute Spearman rank correlation coefficient (descending order)
[a] More highly valued by smaller organizations (negative correlation coefficient)

Figure 3.1: *Differences in decision-making criteria between SMEs and large organisations (only criteria with strong relationship to organization size shown) (Bernroider and Koch (2001)*

Sprott (2000) identified four selection criteria when it comes to choosing an ERP system, these are applicability, integration, adaptability and upgradeability.

Verville and Halingten (2002) reported that the three distinct types of an ERP system evaluation were vendor, functional and technical. Vendor evaluation criteria included vendor size, reputation, financial stability, long term viability and the vendor's vision/corporate direction. Functional criteria dealt with the features of the software,

and included functionalities specific to front-end interfaces, user friendliness and so on. Technical criteria dealt with the specifics of the systems architecture, integration, performance, and security etc.

Rao (2000) identified the criteria for the selection of an ERP system for SMEs. These criteria are affordability, domain knowledge of suppliers, local support, technical upgradeability and incorporation of latest technologies.

Kumar et al. (2003) identified the following factors: functionality, cost, service and support, system reliability, compatibility with other systems, ease of customization, market position of the vendor, better fit with organizational structure, fit with parent/allied organization systems and cross module integration.

Figure 3.2 shows the results of the literature review about ERP selection criteria carried out by Baki & çakar (2005).

	Rao (2000)	Bernroider and Koch (2001) (more important for the small/large)	Hecht (1997)	Shikarpur (1997)	Verville and Hallingten (2002)	Brewer (2000)	Kumar *et al.* (2003)
Functionality			*	*	*	*	*
Technical aspect	*		*	*	*	*	
Cost	*	*/–	*		*	*	*
Service and support	*	–/*	*	*			*
Vision			*		*		
System reliability				*		*	*
Compatibility with other systems						*	*
Ease of customisation		*/–				*	*
Market position of the vendor		–/*			*		*
Better fit with organisational structure		–/*					*
Domain knowledge of the vendor	*						
References of the vendor				*			
fit with parent/allied organisation systems							*
Cross module integration				*	*		*
Implementation time		*/–					

Figure 3.2: ERP selection criteria researched by Baki & çakar (2005)

Shehab et al. (2004) carried out as well a comprehensive review and comparison of papers discussing selection criteria of ERP systems. The results are summarized in Figure 3.3 which is a table extracted from Shehab et al. (2004) paper.

Author(s)	Type and field of study	Size of organisations	Selection factors considered
Siriginidi (2000)	Theoretical	Large size	Stability and history of the ERP supplier Last 12-month track record of ERP sales Implementation support from suppliers Improvement in ERP packages including stability of the product and functionality
Bernroide and Koch (2001)	Empirical Austrian	Mid and large size	Implementation time Adaptability and flexibility of software Costs Vendor support Team size and structure Market position of vendor Customer and supplier needs
Everdingen *et al.* (2000)	Empirical European	Midsize	Fit with business process Flexibility User-friendliness Costs Scalability Supplier support and training Product functionality and quality Implementation speed Interface with other systems Price Market leadership Corporate image and international orientation
Sprott (2000)	Theoretical	Large size	Applicability Integration Adaptability Upgradability
Chen (2001)	Theoretical	Large size	Competitive strategy Targeted market segments Customer requirements Manufacturing environment Characteristics of the manufacturing process Supply chain strategy and available resources
Rao, 2000	Theoretical	SMEs	Affordability Domain knowledge of suppliers Local support Technical upgradable Incorporation of latest technologies
Verville and Halingten (2002)	Empirical USA	Large size	Vendor evaluation Functional and technical aspects of the software

Figure 3.3: ERP selection criteria; comparison of papers (Shehab et al. (2004))

3.2 The Organizations Needs

Going back to the theory research carried out so far about large organizations' and SMEs' ERP selection criteria, here are the needs that I deduce and which will inspire the ERP evaluation model that will be presented in the next paragraph:

For large organizations:

- Large organizations value the aspects related to the flexibility and process improvement that the ERP software is supposed to bring into the organization more than SMEs (e.g. increased organizational flexibility, process improvement and improved innovation capabilities)
- Internationality of the software and customer and supplier needs
- Stability and history of the supplier. This includes also the current market position of the vendor
- Upgradeability and improvement in ERP packages, including stability of the product and functionality as well as improved innovation capabilities
- Short implementation time
- Good support, this includes implementation support
- Integration
- Scalability

For SMEs:

- Adaptability and flexibility of the software. This includes technical upgradeability and incorporation of latest technologies
- A short implementation time
- Lower costs
- Fit with business procedures
- User-friendliness of the system

- Focus on product characteristics such as the functionality and quality of the products and services, rather than on characteristics of the ERP supplier of the product
- Integration or in other words the possibility of the product to interface with other applications
- Good support from supplier and training
- Domain knowledge of suppliers

As it can be noticed some of the needs are shared between the two sizes of organizations.

3.3 The Model for Evaluating ERP Systems

The evaluation of the chosen Open Source ERP systems is going to be performed based on a set of dimensions and features. The defined set of dimensions is inspired from the organizations' needs researched in paragraph 3.1 and summarized in paragraph 3.2. The list of features is compiled by looking at the overall feature offering of different ERP systems. The dimensions and features which form the evaluation model, are presented in Figure 3.4. The evaluation itself will be performed in chapter 4, but in this chapter the dimensions and features will be presented and discussed.

THE FEATURES

- Accounting and financial management capabilities
- Project management capabilities
- Sales management
- Production management
- Warehouse management
- Procurement management
- Business intelligence
- Support for complex entity structures
- Support for automated updates of new tax regulations
- Supports granular roles and permissions
- Multiple currency support and ability to define own currency
- Supports currency conversion rates
- Supports automated currency conversion rates updates
- Automated alerts based on custom conditions
- Web interface with Ajax
- Ability to define multiple custom workflows
- Supports the creation of custom form fields on the fly through the interface
- Accepts substitute products
- Ability to define flexible product types
- Capability to define custom invoice schedule for different customers
- Capability to define custom volume discounts for each customer
- Capability to define custom Units of Measures (UOM) for each employee
- Ability to import products/customers/partners/employees/accounts from xml
- Goods tracking
- Expense sheet
- Employee expenses tracking and reporting
- Tax payments management
- Funds transfer and fund management
- Budget management
- Asset management
- Document management system
- HR contract management
- HR employee holidays and absence management
- Point of Sale
- Time and task management
- Ability to define custom views to show system data
- Ability to define new custom database objects through the user interface
- Define department structures and management structures
- Modules management interface
- Inbuilt chat utility

THE DIMENSIONS

- Cost
- Support availability
- Vision
- Stability and maturity
- Customization
- Scalability
- Ergonomics and user interface

Figure 3.4: *the evaluation criteria: the out-of-the-box features and the dimensions*

3.3.1 The Dimensions

The dimensions that will be utilized in the evaluation model are the following:

Cost

Cost is usually one of the first concerns of companies when considering buying or implementing an ERP package. Affordability is an important criterion in the selecting process; the solution should have an attractive price (Rao, 2000). Setting realistic expectations for the overall cost of the system is essential to gain top management approval (Hecht, 1997). When it comes to Open Source ERP packages, the software itself can be downloaded for free from the vendor's website. The cost components can be hardware, consulting, analysis, license, implementation, customization, maintenance, training, integration, support, upgrades and continuous adaptation to processes.

The cost is influenced by most of the other dimensions and the out of box features of the ERP system. For example, the degree of fit of the out of box features to the intended processes shows the amount of development and customization needed (Herzog, 2006).

Support Availability

Hecht (1997) argues that the service and support associated with the application becomes vital to the success of the partnership between the end user and the application vendor, especially when knowing that installation and ongoing costs can reach seven to ten times the initial software cost. Companies face several difficulties during and after implementation of an ERP, namely integration with existing systems, customization, and security (Themistocleous et al., 2001).

Support helps to shorten the implementation time due to the knowledge transfer to the company. Support is about the ability to quickly tap into the necessary skilled resources who can customize, support and maintain the system. Support includes the support infrastructure, the training and the documentation (Herzog, 2006).

Ensuring a reliable and responsive support is critical for accepting the ERP system or any system by the community of users. The support for Open Source ERP system can be local or online (Herzog, 2006). Many Open Source ERP systems get the support and consulting services of local partner networks with specific industry knowledge to get through problems related to the different national requirements like accounting standards and interfaces to public authorities. Online support in the form of public discussion forums and mailing lists is also of high importance as it offers the opportunity to discuss issues and search for solutions online. For Open Source ERP systems in particular, the size of the community and its organization defines the support quality.

Training is the other aspect of support. It is of high importance to provide quality, regular training for the community of users. In addition, complete and up to date documentation should be made available for both users and developers.

Vision

When a company plans to deploy an ERP system it should take into account the future of the system since it is likely to be utilized for many years to come. The vendor's vision needs to be considered in addition to the vendor's reputation, financial stability, market position, domain knowledge (i.e. the industry in which the vendor's ERP product is most used and best known), references and its products' and services planning for the next 3 to 5 years are things that need to be looked at (Hecht, 1997). Concerning the market position of the vendor, leading ERP vendors have implemented the best global practices in their ERP products. For this reason, companies can look at the ERP product as a process advisor (Shikarpur, 1997). Sales references, and internationality of the vendor, and especially completed successful project in the same industry could be considered as important criteria for the selection process (Baki & çakar, 2005).

Stability and Maturity

The vendor's system reliability and how long the ERP vendor has been in the core ERP solution business are critical to know before selecting an ERP solution for production usage. According to Kumar et al. (2003), the system's reliability is the second most important selection criterion. For the case of Open Source ERP solutions, it is relatively easy to get hold of such information by researching internet forums for such opinions and experiences with the system.

Maturity tells you how well and bug free it is implemented and tested (Herzog, 2006). Herzog argues that criteria of the stability of a release are reference sites listed on the Open Source ERP project homepage and the availability of documented business cases.

Customization

Ease of customization is an essential criterion to companies seeking to adopt an ERP system. Because of the need to adapt the generic solution to the company's specific needs, ERP vendor is required to provide tools and utilities that will allow the firm's in house IT personnel or independent consulting firms to customize the software (Avshalom, 2000). In the majority of research papers discussing selection criteria for an ERP software, adaptability and flexibility of the software has always appeared to be one of the most important criteria.
The degree of functional fit of the out of box features determines the amount of customization needed of the adopted ERP. The higher the fit, the lower are the implementation and customization costs and the faster is the implementation time.

The degree of functional fit of the out of box features determines the amount of customization needed of the adopted ERP. The higher the fit, the lower are the implementation and customization costs and the faster is the implementation time. Herzog (2006) distinguished between two levels of customization:

- High level customization through meta data editing: this means the customization is carried out by manipulating and editing readable and understandable data instead of intervening at the level of the written code. No programming experience is anyone with knowledge of the business should be able to customize the system. This shortens the learning path and therefore accelerates the implementation and gives more freedom to the company to continuously adapt the system to the processes and the business needs.
- Low level customization: this includes developers intervening at the code level. This allows more flexibility, and the ERP system defines the software architecture and allows the addition of custom operations.

Scalability

ERP solutions should be designed to grow with your company. Scalability of an ERP system is its ability to continue to function well when the conditions change in terms of size or volume. Scalability most often comes into play when the company anticipates growth in its business, whether in the form of number of simultaneous users connected or number of transactions per second. Making a significant investment such as in an ERP system, the company needs to make sure that the system can grow as the business grows. On the other hand, the company wouldn't want to pay for excess capacity while waiting for growth to happen. A scalable system can be downsized as easily as it can grow. Scalability is highly dependent on the architecture and thus on the application server and database technology used (Herzog, 2006).

Ergonomics and User Interface

In any software adoption project, the end user should always be kept in mind. He or she is the one who is going to use the software after all. If the software turned out to be difficult to use, resistance will build up and this can announce the failure of the

project. Usability is one of the major aspects of an application, and so a lot of time needs to be invested to make sure to get it right.

Usability measures the user's perception of how easy the applications are to use, how "in command" of the application a user feels, how easy it is to navigate in the software, and how much the user enjoys using the software. An application's value to an organization and its impact on business performance can be maximized through greater application ease of use. High user productivity is driven by more than an appealing user interface.

The ergonomics of the system can include the navigation between screens, the use of keyboard shortcuts, Ajax auto-completion, personalized controls, and internationalization of the ERP system, among others. Performing a simple routine task for example shouldn't require navigating through many screens. User friendliness has a bearing on customization possibilities, user acceptance, training costs and operations costs (Herzog, 2006).

Internationalization is the ability of the system to support multiple languages, provide translation for multiple accounting and costing schemes and support multiple sites. It can be distinguished between simple translation of static graphical user interface (GUI) parts for example the menus, and the translation of the dynamic parts of the GUI and the content.

An ERP system offering the possibility of supporting multiple languages has a bigger advantage in gaining a wider international user base and reduces the risk of project fragmentation with dispersed communities and weaker collaboration. When it comes to multiple site support, it is about the ability of the ERP system to incorporate different accounting and costing schemes which are usually dictated by legal national requirements.

3.3.2 Out-of-the-box Features

The out-of-the-box features of an ERP system are usually of importance for small and medium sized organizations. Indeed, SMEs are usually on a tight budget and will attempt to keep the system's customization at a minimum and take advantage as much as possible of the default features of the system.

Because of the importance of out-of-the-box features to SMEs, the open source ERP systems that will be selected will be evaluated against critical features that came to be expected out of commercial proprietary ERP system.

The following out-of-the-box features and capabilities will be evaluated in the Open Source ERP systems under scrutiny

- Accounting and financial management capabilities
- Project management capabilities
- Sales management
- Production management
- Warehouse management
- Procurement management
- Business intelligence
- Support for complex entity structures
- Support for automated updates of new tax regulations
- Supports granular roles and permissions
- Multiple currency support and ability to define own currency
- Supports currency conversion rates
- Supports automated currency conversion rates updates
- Automated alerts based on custom conditions
- Web interface with Ajax
- Ability to define multiple custom workflows
- Supports the creation of custom form fields on the fly through the interface
- Accepts substitute products
- Ability to define flexible product types

- Capability to define custom invoice schedule for different customers
- Capability to define custom volume discounts for each customer
- Capability to define custom Units of Measures (UOM) for each employee
- Ability to import products/customers/partners/employees/accounts from xml
- Goods tracking
- Expense sheet
- Employee expenses tracking and reporting
- Tax payments management
- Funds transfer and fund management
- Budget management
- Asset management
- Document management system
- HR contract management
- HR employee holidays and absence management
- Point of Sale
- Time and task management
- Ability to define custom views to show system data
- Ability to define new custom database objects through the user interface
- Define department structures and management structures
- Modules management interface
- Inbuilt chat utility

An explanation of the features above can be found in the appendix

CHAPTER 4: THE EMPIRICAL STUDY

4.1 The Chosen Open Source ERPs

In the beginning of this study, an extensive research has been made to identify and make a preliminary analysis of the current leading Open Source ERP systems. The following systems have been identified:

- Open ERP
- OpenBravo
- ERP5
- Opentaps
- Compiere
- Adempiere
- WebERP
- BlueERP
- GNU Enterprise

After a preliminary research on each of those systems, it became evident that only a few deserved being looked into in more details due to their competitive offering. The three systems OpenERP, OpenBravo and Adempiere ended up being retained for a more in-depth analysis. The following summarizes the main reasons behind the non-selection of the remaining systems.

ERP5: While ERP5 seemed to have extensive features, the quality and amount of the documentation available was not as satisfactory as the material available for OpenERP, OpenBravo and Adempiere.

OpenTaps: OpenTaps looked promising at first and was initially included in the choice of systems to evaluate. However, after a short period of time testing OpenTaps, several functional issues started to appear. Not being able to conduct appropriate testing, it was decided to leave OpenTaps outside the selection.

Compiere: Compiere seems to be a stable and fully functional ERP. However, Compiere currently does not use freely available database (except of Oracle Express which is not Open Source). Because this research is looking into Open Source solution stacks, Compiere was not selected.

WebERP: At the time of review, WebERP did not seem to be as mature as the selected ERP systems. It also did not contain HR and project management modules.

BlueERP: BlueERP lacked in the documentation available

GNU Enterprise: GNU enterprise seems to be a mature system, but it is not user friendly and cannot be used out of the box same as the selected systems. However based on the research it was obvious that GNU Enterprise was a production ready solution for organizations willing to design their own flexible ERP solution

Here is a small introduction to the three chosen systems that will be evaluated:

OpenBravo: OpenBravo is a web-based, Open Source ERP business solution mainly intended for SMEs, released under the OpenBravo Public License, based on the Mozilla Public License. The license ensures public access to source code and permission to freely modify source code. The OpenBravo project is among the top ten most active projects of Sourceforge as of January 2008 (SourceForge is a web-based source code repository that provides and promotes Open Source software

downloads, development, discussion and news). Openbravo ERP has been designed as a single ERP application: all functionalities share a common architecture, philosophy, rules and user interface, and all are seamlessly integrated.

OpenERP: OpenERP is published under the GNU General Public License (GPL). Open ERP is known to be very complete and extremely modular, with 350 available modules. It is based on a strong MVC (Model – View – Controller) architecture, with a distributed server, flexible workflows, an object database, a dynamic GUI, an XML-RPC (Extensible Markup Language – remote procedure call) interface, and customizable reports. OpenERP used to be known under the name TinyERP.

Adempiere: Adempiere was forked (split) from the well-known Open Source ERP/CRM project Compiere on September 1st, 2006, after a long but gradual deterioration of the relationship between Compiere Inc. and its Open Source community. The fork was sparked by rumours that Compiere would radically limit the functionality of its open source offering to better position its upcoming "Enterprise Compiere" a closed source solution. The software is licensed under the Free Software GNU General Public License and offers Enterprise Resource Planning, Customer Relationship Management and Supply Chain Management functionality.

4.2 The Empirical Study of the Systems: The Features

As mentioned in chapter 3, each system will be evaluated against the set of dimensions and features defined in chapter 3. The evaluation against the set of chosen out-of-the-box features will be done following a binary logic. The reason behind choosing to carry out the evaluation following a yes/No logic is to keep the study as objective as positive. Any attempt to rate each feature will remain purely subjective based on the sole opinion of the writer. The results of the evaluation are presented in table 1 below.

Table 1: the out-of-the-box features

Capability	OpenBravo	OpenERP	Adempiere
Accounting and financial management capabilities	Yes	Yes	Yes
Project management	Yes	Yes	Yes
Sales Management	Yes	Yes	Yes
Production management	Yes	Yes	Yes
Warehouse management	Yes	Yes	Yes
Procurement management	Yes	Yes	Yes
Business intelligence	Yes	Yes	Yes
Support for complex entity structures	Yes	Yes	Yes
Support for automated updates of new tax regulations	No	No	No
Supports granular roles and permissions	Yes	Yes	Yes
Multiple currency support and ability to define own currency	Yes	Yes	Yes
Supports currency conversion rates	Yes	No	No
Support automated currency conversion rates updates	No	No	No
Automated alerts based on custom conditions	Yes	No	No
Web interface with Ajax	Yes	Yes	No
Ability to define multiple custom workflows	No	Yes	Yes
Supports the creation of custom form fields on the fly through the interface	No	Yes	No
Ability to define custom categories for customers, suppliers and employees	Yes	No	No
Ability to define custom categories for products	Yes	No	Yes
Accepts substitute products	Yes	No	No
Ability to define flexible product types	Yes	Yes	Yes
Capability to define custom invoice schedule for different customers	Yes	Yes	No
Define custom payment terms for each customer	Yes	Yes	No
Capability to define custom volume discounts for each customer	Yes	No	No
Define custom salary category for each employee	Yes	Yes	No
Capability to define custom Units of Measures (UOM) for each product/service	Yes	Yes	Yes
Ability to import products/customers/partners/employees/accounts from xml	Yes	Yes	No
Goods tracking	Yes	Yes	Yes
Expense sheet	Yes	Yes	No
Employee expenses tracking and reporting	Yes	Yes	No
Tax payments management	Yes	Yes	Yes
Funds transfer and fund management	Yes	Yes	Yes
Budget management	Yes	Yes	Yes
Asset management	Yes	Yes	Yes
Document management	No	Yes	No
HR contract management	No	Yes	Yes
HR employee holidays and abscence management	No	Yes	No
Point of Sale	Yes	Yes	Yes (via 3rd party)
Time and task management	No	Yes	No
Ability to define custom views to show system data	No	Yes	No
Ability to define new custom database objects through the user interface	No	Yes	No
Define department structures and management structures	No	Yes	No
Module management interface	No	Yes	No
Inbuilt chat utility	No	No	Yes

4.3 The Empirical Study of the Systems: The Dimensions

The evaluation against the set of dimensions will be done in a more qualitative way

4.3.1 OpenBravo

Cost

For OpenBravo, the following cost components have been looked at: licenses cost, customization cost, and maintenance cost.

When it comes to licenses cost, all modules or features of OpenBravo are under an Open Source license, however OpenBravo license is not OSI compliant. Customization may incur some extra costs with OpenBravo, as there is the need for development to customize screens, logic, layout of reports and to add/customize statistical reports.

Concerning maintenance costs, OpenBravo offers a fixed price maintenance contract, including unlimited bug fixes guarantee, migrations, and a three year compatibility guarantee

Support Availability

The first level support for all OpenBravo products is provided by the network of OpenBravo partners spread all over the world. Their services include application of patches and updates, backup strategy and execution, handling of hardware issues, and end user support.

OpenBravo invests in a wide community activity. A Wiki is made available for the community of developers and users. The forum of OpenBravo on Sourceforge.net shows a very high activity with a big number of people accessing it every day. The OpenBravo community of contributors dedicate the time to answer the incoming questions and diffuse their knowledge on the support forum. The Wiki is the place to be informed about the latest news, and most importantly to have access to the software's documentation. The Wiki provide technical documentation for people installing, configuring or developing the OpenBravo ERP. Subjects of documentation

include: the system's architecture (main development concepts, the system's modularity, etc.), installation, localization, development (the developers' guide for example), community documentation (contributor's guide, community projects, community communication channels, etc.), user documentation (user manual, functional documentation, etc.), configuration and deployment documentation (OpenBravo ERP configuration manual, setup guide, guidelines for customizing the ERP's look and feel, etc.).

A bug reporting tool is available at https://issues.openbravo.com. It serves as a database of defects and feature requests for the Openbravo projects. It helps developers keep track of issues and who is fixing them. A collaboration platform is available at http://forge.openbravo.com which allows third parties to independently develop projects which are synergetic with OpenBravo software. Projects hosted on this platform enjoy several services such as forums, news, downloads, bug tracking, Subversion, Wiki and central repository modules. A blogs' space is also created where developers and contributors can write and share articles and news.

Training is another component of support. OpenBravo offers an exhaustive catalogue of professional training courses. This offer includes: scheduled training courses, online courses, tailor-made training courses and an access to detailed training materials and a solid training system environment.

Vision

OpenBravo's mission is to offer the best possible management system and the tools needed for successful development and implementation.

OpenBravo's strategic objectives are to:

- lead development of the best Open Source ERP product and platform on a worldwide scale, actively involving the community
- disseminate OpenBravo by leveraging on the Open Source community and the existing media attention

- develop an innovative and preferred offering around OpenBravo for partners and end users
- attract, develop and maintain the best possible team offering a meritocratic working environment that fosters team play and a high level of commitment

Stability and Maturity

One of the criteria that reflect the software maturity can be the market reputation and position. The market position can be measured or assessed by looking at the reference sites or success stories listed on the vendor's website, the number of documented business cases and the number of integrators supporting the software. OpenBravo enjoys a positive reputation on the market and a strong market position. There are more than hundred integrators offering their services to support the integration of the software. There are as well more than hundred success stories, some of them illustrated on the vendor's website. From the success stories and the criticality of the issues reported by the customers, it is sensed that the solution offers a good degree of stability and maturity.

Customization

OpenBravo's user interface supports skins that make it possible to create a new look and feel beyond the skin provided by default (a skin is a custom look and feel of an application or graphical user interface (GUI)).

The OpenBravo platform offers the opportunity to package the development contributions of the community into modules. These modules can include: localization packages for languages and accounting schemes, functional extensions (add-ons to the current functionalities, or creation of new modules), verticals (verticals are developments made for specific industries), and customizations module for any other modifications.

OpenBravo offers several customization tools and options: regarding screen design capabilities, OpenBravo offers an editable menu structure and the ability to modify the layout of the screen without development. However, it doesn't offer the possibility to easily add fields on the screen without the need for development. OpenBravo's report designer offers the possibility to easily add tables in the reports and supports all kinds of formatting elements. However, it doesn't offer the possibility to add pictures or computed graphs. OpenBravo's object designer offers the ability to create new fields and tables. OpenBravo remains limited when it comes to modularity, it doesn't offer for instance the ability to package any modification as a module, addon or plugin. Moreover, it doesn't offer to reuse existing configuration easily. OpenBravo doesn't offer the possibility to edit workflows.

Scalability

Referring to chapter 3, the scalability of a system is its ability to grow with the growth of the business (an increase in the number of simultaneously connected users or in the number of transactions per second) as well as its ability to be downsized when needed.

By referring to the study realized by Smile (Valyi, 2008), for small loads, there is a need for a bigger machine to host an OpenBravo server, namely in terms of RAM (> 1GB minimum) than to host an OpenERP server. However, after a certain load level, OpenBravo offers a better performance for the same machine.

OpenBravo, with the maturity of stored procedures and their systematic use, can guarantee very acceptable and satisfying performance levels. Moreover, for more critical cases, OpenBravo can be used with an Oracle database, which offers a better performance than a PostgreSQL database. This makes OpenBravo suitable for large deployments in such business areas as distribution, logistics and manufacturing.

Ergonomics and User Interface

OpenBravo and Open ERP offer good ergonomics namely by offering personalized shortcut solutions and links between documents. OpenBravo namely can get the highest rating, with a very attractive and professional design. OpenBravo has implemented as well in its 2.40 version all the usual keyboard shortcuts (CRTL+S, etc) in its web interface. OpenBravo offers in its interface a tooltip on all fields and a graphical process on every screen.

4.3.2 OpenERP

Cost

For OpenERP, the following cost components have been looked at: licenses cost, customization cost, and maintenance cost.

When it comes to licenses, all modules and features of OpenERP are under an OpenSource license which is OSI compliant and totally free. Regarding cost of customization, with OpenERP the cost of customization is considerably reduced because there is no need for development to customize screens, logic, layout of reports and statistical reports. Concerning maintenance agreements, OpenERP offers a fixed price maintenance contract, including unlimited bug fixes guarantee, migrations, and a five year compatibility guarantee.

Support Availability

A users' forum and mailing lists are available for users to request help on general topics such as a functional question, or a configuration problem, etc.

A developers' forum and a technical mailing list are available for contributors to ask for help about a bug resolution for example.

When it comes to documentation, a Wiki is used for collaborative documentation authoring. All documentations about OpenERP are maintained in the official Wiki. OpenERP provides as well an official bug tracker, forum, IRC channel, Wiki for documentations, and an official repository of sources.

Documentations for end users, integrator, developpers and the community are made available for free on OpenERP website. These documents, beside being made available online, are integrated as well in the OpenERP system as well for contextual help, and linked to any screen of the software so that it can efficiently help users to work efficiently with the software. An “OpenERP book” explaining how to install, administer, configure and implement the system and giving guidelines and necessary elements, from a functional point of view, of how to efficiently manage the different enterprise business processes: accounting, operations, stock and manufacturing, sales and purchasing etc. Other documents include:

- the “installation manuals”
- the “developer book” for how to develop your own modules,
- the “community book” giving guidelines of how the community of contributors and users is organized, how coding should be done and showing the means of communication for the community members

OpenERP provides as well online and free learning screencasts.

Vision

OpenERP’s vision is to build up the best enterprise management software ever developed. The focus is to build a perfect organization between all Open ERP’s actors. So that the contributions and feedbacks from the community can be leveraged, as well as the market knowledge and creation from partners and the quality control and vision of an editor. OpenERP’s focus is on creating a fully Open Source development methodology.

Stability and Maturity

As mentioned in chapter 3, the ERP stability and maturity can be measured by looking at the vendor's market position, the reference sites listed on the vendor's website and the number of documented business cases.
OpenERP has been integrated in a wide range of companies across different sectors. In addition, OpenERP is very well present on a big number of markets (more than 45 countries), with a big number of integrators offering their services, more than a 100 documented success stories, many of them can be found on the company website.

Customization

One of the biggest advantages of Open ERP is that it is built on a powerful architecture, the Open Object platform. It allows the customization of applications in a few hours without development or to develop new features very quickly. Today's time to market is getting shorter, business needs change constantly and so do requirements, hence the need to adapt and develop fast. Open Object is a smart Open Source professional rapid application development (RAD) framework in Python (Python is a general-purpose high-level programming language). Developments and customizations can be packaged as modules and new modules can be installed on demand from the user interface. Open Object engine allows customizing all actions of the system in a few clicks: defining new objects, modifying workflows, changing the result of actions, opening new windows or reports, etc.

All features of Open ERP are packaged as independent modules and work independently, allowing the company to install only a few of them. The company can also generate their own modules without development, using the customization tools and options offered by OpenERP: technical workflow editor, object designer, view or screen designer, report designer, BI reports, customizable actions, customizable documentation, modularity, etc.

All customizations made on the server can be saved as a module to easily deploy, redistribute and share. The Open ERP view editor or screen editor allows designing and adapting all screens of the application to the user's specific needs. The user can easily modify the layout of any screen, add/remove new fields anywhere on the screen, and add HTML in views. The workflow editor, part of the integrated Business Process Management engine of OpenERP, allows changing the logic of all document processing to adapt it to the enterprise needs. The object designer allows to create new fields, new tables and to keep track of all versions of each object. Open ERP is modular which means it offers the ability to package any modification as a module /addons/plugin, reuse existing configuration easily, distribute existing configuration and define several menu suites for the same system. The flexibility of this system will allow the software to evolve with the company needs.

Other applications can be easily integrated with the Open ERP server and can therefore access the objects and services of the OpenERP application through different Web Services standards: XML-RPC, XML-RPC over HTTPS (Hypertext Transfer Protocol Secure), etc.

Scalability

Referring to chapter 3, the scalability of a system is its ability to grow with the growth of the business (an increase in the number of simultaneously connected users or in the number of transactions per second) as well as its ability to be downsized when needed.

By referring to the study realized by Smile (Valyi, 2008), for small loads, there is a need for a bigger machine to host an OpenBravo server, namely in terms of RAM (> 1GB minimum) than to host an OpenERP server. However, after a certain load level, OpenBravo offers a better performance for the same machine.

In any case, the study shows that OpenERP still presents limited scalability even though it got improved lately. In the beginning of 2008, there were serious doubts about the ability of OpenERP to handle big volumes or requests because of the use of high level of abstraction. However, things got improved in version 5 of the software but there is no tangible data quantifying the improvement.

Ergonomics and User Interface

The user interface of Open ERP is comfortable and well designed. Because it is built based on the Open Object platform it allows to develop applications with a very good usability and that are highly user friendly: Ajax web and rich interfaces (with the same package, one will get a rich application and a web interface to satisfy the different users' needs), drag and drop, flexible screens, dynamic content, lots of different views (resources can be displayed as calendar, graph, tree, form, process, Gantt chart or lists without much development effort), powerful configurable dashboards that are fully dynamic and customizable per user, data filtering, searching, importing and exporting. A template engine is also made available to provide customizable templates and therefore adapt the look and feel to the corporate identity.

OpenERP offers also integration with Microsoft Office, OpenOffice and Webmail which improves the productivity of the users. Information visibility is made easy through easy switch between list and form view, to Business Intelligence interface, to graphs, and to Gantt and calendar views.

When it comes to the internationalization aspect, the translation is performed mainly on the server side and to a small degree on the client's side. It provides translation to the content of the form fields, showing the lists of values in different languages. The user interface (GUI) remains in a somehow mixed language due to the little translation done on the client's side.

OpenERP can be considered to offer a fast learning curve with many companies being able to carry out the integration of the software by themselves.

Documentation accessibility is another factor that impacts the usability of the software. OpenERP provides tooltips on all fields as well as technical documentation on all tables/objects.

4.3.3 Adempiere

Cost

Adempiere is committed to be a fully Open Source system, it is subject to a "real" open source license (GPLv2). The system can be used without licensing costs now and in future. A global community constantly enhances ADempiere. However, due to the fact Adiempere doesn't offer a web based version of the system, we expect that maintaining the system may incur additional costs.

Support Availability

Adempiere offers its community a Wiki to contribute and share knowledge and domain expertise. Adempiere offers as well a comprehensive documentation to assist the community in their work with the Adempiere software. Available categories of documents include developer, functional, technical, user and security documentation and implementation manuals among others. Main documents include:

- a functional user manual intended for business people who want to learn how to use the system and meant to explain the context of the application,
- a reference user manual offering technical help
- Adempiere's best practices outlining the practices to be followed for development within Adempiere to ensure a high standard of quality

When it comes to training, Adempiere has a limited training offer. This is limited to some published articles on the website and some training seminars in different locations from time to time.

Regarding support for bugs, Adempiere follows a very open approach to contribution. The vendor offers to its community tracking systems bugs, patches, feature requests and technical support.

When it comes to the availability of partners offering their services to support the Adempiere system, we couldn't find as many partners supporting the system as those who support OpenERP for example.

Adempiere makes available for its community members an IRC chat channel as well as a virtual conference room to communicate and share knowledge.

Adempiere project created the Business Development Committee, formed among members with extensive business experience in implementing ERP solutions. The mission of this committee is to offer a quality service for those prospects requesting such services. In the words of Adempiere, the Business Development Committee can be considered as a very large virtual consulting house.

Vision

Despite the statements made right below (see Stability and Maturity), Adempiere seems to have a pretty reassuring roadmap especially with the plan to develop a web based user interface. The main risk is that no development of such size has been carried out since the split from Compiere in 2006. This brings someone to be cautious and wonder whether Adempiere has the ability to realize such a project currently.

Adempiere's vision is to remain a 100% Open Source project, after all it is the reason for which Adempiere chose to split from Compiere.

Stability and Maturity

If we look at the evolution of Adempiere until now, it consists of:

- bug fixing of the version that was taken from Compiere at the moment of the split of Adempiere from Compiere in 2006
- several specific extension developments but which are not or little integrated with Adempiere, and which can hardly be considered as real coherent improvement of the product.

However the company is evolving and is actively encouraging contributions coming from all over the world. Adempiere shows on its website several implementation success stories and testimonies from clients and partners. This can be considered to be a positive sign of maturity of the system.

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Customization

Adempiere offers the possibility to customize with and without the need of development.

For customization without development, it can be done through Adempiere's Application Dictionary (AD). This tool allows for the management of the application's entities and their validation rules, as well as screen layouts and display logic from within the application itself. The AD's Application Dictionary resolves the Model-View-Logic model of modern software design: the AD's Model Layer takes care of all entities such as the core database table & field structure, its datatype, reference and validation rules. The View Layer takes care of its presentation in both the Java and HTML clients without the developer needing to code a single line of extra user interface code. The AD's Logic Layer is where all the business logic and auxiliary activity happens.

These features allow for rapid customization of the application to business needs as they evolve.

Some customizations are not possible to achieve through ADempiere's application dictionary and someone has to modify the source code for that. Adempiere's makes available on its website a set of recommendations and hints for how to realize such customizations.

Scalability

Even if Adempiere has reached a certain status and reputation of a proven ability to handle big loads, its future evolution will face the hurdle of a heavy and difficult to change code base. The main criticism towards this platform is its use of programming paradigms which are little productive and outdated; the functional code is written almost completely in PL/SQL (Procedural Language/Structured Query Language, is Oracle Corporation's proprietary procedural extension to the SQL database language, used in the Oracle database) while the preference today is to have a higher level of abstraction in programming with use of Object Oriented Programming. The business code of Adempiere contains a big number of lines of stored procedures in PL/SQL, and this fact has its consequences. This procedural code presents more difficulties in managing a growing complexity (which is the case of an ERP, and ERP is highly complex) than a code which is written using objects (Object Oriented Programming). This latter allows to build data structures by inheriting from others which minimizes the risk of introducing errors in the code and limits the development efforts that need to be provided. Therefore, an ERP such as Adempiere based on a procedural code, is less adapted to support functional extensions.

Ergonomics and User Interface

Adempiere still doesn't have a web interface. Even if the will of some integrators is there, given the effort needed to develop this and the actual governance of

Adempiere, it seems very uncertain to count on realizing a very ergonomic and reliable web interface.

The look and feel of a graphical user interface comprises aspects of its design, including elements such as colors, shapes, layout, and typefaces. (the "look"), as well as the behavior of dynamic elements such as buttons, boxes, and menus (the "feel"). The goal of user interface design is to make the user's interaction experience as simple and intuitive as possible. Adempiere offers some tools and tips of how to improve its look and feel. The first tip is about integrating JGoodies. The JGoodies main benefits include improved readability, legibility and in turn usability, improved aesthetics, simplified multi-platform support and precise micro-design. Another tip is about using an appropriate icon set like Tango Desktop Project. This project helps create a consistent graphical user interface experience for free and Open Source software. Main Benefits include a suggested default native look, visual consistency of applications coming from different communities, sharing graphic resources, incorporating elements of Windows XP, Mac OS X, KDE (K Desktop Environment) and GNOME style into the mix (KDE is a desktop environment for Unix-like systems. GNOME is a desktop environment—the graphical user interface which runs on top of a computer operating system—composed entirely of free software).

CHAPTER 5: CONCLUSION

This chapter summarizes the findings that we've been discussing so far and links them back to the research hypotheses that were defined in paragraph 1.2

In chapter 4, I tried to present mainly the facts about each system with as much objectivity as possible. In this concluding chapter, comparison will be used sometimes to give a glimpse of the differences between the systems. This comparison will stay more limited than comprehensive.

Despite the similarities between the systems, there are some functional differences that can tip the balance in favor of one ERP system versus the other, when those ERPs are being looked at by taking into consideration the functional modules that they offer (for ex. accounting and financial management capabilities, project management capabilities, sales management, production management, warehouse management, procurement management, business intelligence, etc.), the type of industry (distribution, services, manufacturing etc.), and the size of the organization (large vs. SMEs).

From a Functionality and Type of Industry Point of View

The most pronounced differences can be felt in the Human Resources module, where OpenERP can be considered the most complete among the three systems. Having a good HR management is very often a prerequisite or a success factor for good project management, and that is why OpenERP can be considered more

successful than its two other competitors when it comes to the project management module.

OpenERP has also advantages over the other two other ERPs when it comes to the CRM module where OpenBravo presents some limitations. The strong point of OpenBravo remains its web interface.

OpenBravo can be considered to have reached a high level of maturity when it comes to the production management module (or feature as I called the modules in chapter 4). This maturity in production management makes OpenBravo very adapted and suitable to the manufacturing sector. OpenBravo has as well an elaborate Point of Sale module which makes it suitable for the distribution industry.

The distribution industry needs revolve mainly around a good inventory management system, precise pricing policies and webservices to interface with other application such as an e-commerce sales platform (Valyi, 2008). Those needs are in general standard ones and all of the three ERPs are able to satisfy them in a way or another. The pricing engine is pretty much similar among the three systems. The three systems offer as well good inventory management by providing visibility not only over the volumes of the inventory left but also of the inflows and the outflows. The distribution industry implies important sales volumes, and here the database of the system becomes an important parameter, especially in its ability to handle such big volumes and remain performant. When it comes to this aspect OpenBravo and Adempiere offer a more secure and scalable choice since they offer the possibility of being used with an Oracle database.

The services sector, as most of its activities are carried out in a project mode, have a key need of being able to budget a project and compare those budgets to the human resources that were consumed by the project. As mentioned earlier, the human resources and project management modules are not the strongest point of OpenBravo and Adempiere, therefore they may not present the best choice for a services company. On the other hand, OpenERP is very mature in this area, allowing to effectively manage the resources, the planning, the absence requests and other

aspects of managing resources. Project management is made easier through the use of dashboards which offer the project manager a personalized and follow up and monitoring of the projects. As mentioned in chapter 4, OpenERP has an integrated Business Process Management (BPM) functionality which facilitates the handling of complex organizational workflows and bring flexibility and agility to the services organization.

The manufacturing industry most obvious needs are essentially about warehouse management, and production orders management. All three selected Open Source ERPs can satisfy those needs.

Analysis from the Size of Organization Point of View

This analysis is intended to respond to the second and third research hypotheses. Those were:

- Today's Open Source ERP systems are suitable for SMEs
- Today's Open Source ERP systems are suitable for large organizations

From the beginning of this study, it was distinguished between two company sizes: large and SMEs.

In chapter 3, the needs of large organizations and SMEs from an ERP system were researched. Those later on formed the basis of the evaluation model's "dimensions" presented in paragraph 3.3. Several needs came out of this study, and here is a quick summary of them:

For large organizations:

- Large organizations value the aspects related to the flexibility and process improvement that the ERP software is supposed to bring into the organization more than SMEs (e.g. increased organizational flexibility, process improvement and improved innovation capabilities)

- Internationality of the software and customer and supplier needs
- Stability and history of the supplier. This includes also the current market position of the vendor
- Upgradeability and improvement in ERP packages, including stability of the product and functionality as well as improved innovation capabilities
- Short implementation time
- Good support, this includes implementation support
- Integration
- Scalability

For SMEs:

- Adaptability and flexibility of the software. This includes technical upgradeability and incorporation of latest technologies
- A short implementation time
- Lower costs
- Fit with business procedures
- User-friendliness of the system
- Focus on product characteristics such as the functionality and quality of the products and services, rather than on characteristics of the ERP supplier of the product
- Integration or in other words the possibility of the product to interface with other applications
- Good support from supplier and training
- Domain knowledge of suppliers

As it can be noticed some of the needs are shared between the two sizes of organizations. How able are the chosen three Open Source ERP systems (OpenERP, OpenBravo and Adempiere) to satisfy those needs? The answers can be found in the detailed analysis that was carried out in chapter 4. However, here is a general summary of the ability of those systems to satisfy those needs:

For large organizations:

- Regarding the fact that large organizations value the flexibility that the ERP software is supposed to bring into the organization, it can be said that all three systems can satisfy this need.
- When it comes to the internationality of the software, all three systems support multicurrency and multiple languages. However a gap was found in the accounting support of the three systems. Indeed while most of the systems have an inbuilt support for the accounting principles used in large and developed countries, they lack support for the accounting principles of less industrial countries. This can be a large issue for international and large public organizations.
- Regarding history, stability and market position of the vendor, relatively all open source don't have a long history, many are recent players that haven't been in the market for many years.

For SMEs:

- Customization and fit to business procedures: very small organizations many times don't even afford the extra cost of specific development needed on occasions. For this reason, their choice of an ERP system will go for the one that can be easily configured and maintained without the need for development skills. All three systems can answer this need. Open ERP in particular, who is based on a very modular and flexible technology can offer a very good choice for a smal/mediuml organization. It can adapt easily to the company's business processes through its integrated BPM module, which doesn't require any specific development. This is also possible with OpenBravo however this comes at the expense of specific development (there is no BPM included in OpenBravo). OpenERP seems to offer the most appropriate choice regarding the "fit to business procedures" aspect.

- Cost: Open Source ERPs are intended to be available to organizations with the least of amount of cost possible, and regarding this aspect all three systems are practically similar, devoted to remain purely Open Source. For example, in the OpenERP case, very small organizations which do not want to invest neither in the integrating specific developments nor in the maintenance of their server, can invest in the hosted solutions offered by OpenERP at very competitive prices.
- Ergonomics and user friendliness: both OpenBravo and OpenERP seem to offer a very good choice in this category, even though OpenERP takes the prize in this category. OpenBravo made the choice to offer a web interface since its split from Compiere in 2002. This web interface is available for all the functional modules that this OpenSource ERP system offers, for free and under the Mozilla Public License (MPL). On the other hand, with Adempiere, this possibility is not totally in place yet, and the work being carried out by some specialized integrators is still in its early stages and not completely reliable.
- Regarding domain knowledge of suppliers, both OpenERP and OpenBravo seemed to be more ready than Adempiere

Regarding *common needs* between large organizations and SMEs:

When it comes to upgradeability and improvement in ERP packages, it can be said that all three can meet this need.

Another common need is the quality of support provided. Referring to what have been written in chapter 4 about the support dimension, all three systems offer adequate support to their clients. All three have very dynamic and active communities ensuring the correction and follow up on bugs among other support aspects.

When it comes to scalability, all three systems present some limitations. There are still some doubts about the ability of those systems to handle big volumes or requests because of the use of high level of abstraction.

Concerning integration with other systems, all three systems offer the possibility of interface with other applications through web services. OpenERP for example allow other applications or machines to be easily integrated with the Open ERP server and therefore access the objects and services of the OpenERP application through different Web Services standards: XML-RPC, XML-RPC over HTTPS or Python NET-RPC for faster accesses. OpenERP incurs the least integration costs thanks to very advanced graphical configurations and the simplicity of the code itself.

5.1 Final Word and Suggestions for Future Research

Open Source ERPs seem to be following a sustainable growth path and general acceptance thanks to the efforts of their respective communities of contributors. Those systems are coming to a maturity in the functional modules that they offer that can soon be compared to that of proprietary ERP systems. With their strategy of open and accessible code, they offer an incomparable flexibility and allow a close functional fit to the business processes of the organization. This accessibility of the code facilitates the transfer of knowledge and competencies to the internal staff of an organization, which implies a faster reaction to the changing business requirements. As a summarized conclusion, we can say that the chosen Open Source ERP systems offer an adequate level of support to their clients. Moreover, they are suitable for SMEs for the reasons discussed above. However, the chosen Open Source ERPs presented limitations when it came to their use by large organizations: those limitations can be summarized to their scalability as there are still doubts about the ability of those systems to handle big volumes of users or requests, and their ability to be scaled in cluster-like modes. Another limitation impacting large organizations is the lack of support for international accounting principles which will present a large overhead to international companies (as are often large organizations).

When it comes to future research, we believe that taking into consideration the speed at which the Open Source ERP systems are evolving in terms of functionalities,

technology and support, it would make sense to repeat this same study in three to four years of time to check whether Open Source ERPs have acquired the necessary abilities that will make them attractive to large organizations as much as proprietary ones are. Another research could be to run a survey, or any other mean to collect empirical data, to evaluate the actual utilization and the penetration rate of Open Source ERPs in large organizations and SMEs. Another suggestion for future research is to carry out a comparative study between leading Open Source ERPs and some flagship proprietary ones.

APPENDIX: Explanation of the Evaluated Features

Support for complex entity structures

Ability to define multiple organizations in a hierarchy. Support for company structures is a typical need by large organizations with multiple daughter companies.

Support for automated updates of new tax regulations

Leading ERP systems provide support for integrating up to date tax regulations within their systems

Supports granular roles and permissions

Support for granular roles and permissions is one of the many important features of an ERP system. It allows the definition of boundaries and rights upon certain resources. The more granular the feature is the more powerful and flexible it is, and will be more likely to suit a random organizational structure.

Multiple currency support and ability to define own currency

Ability to utilize the system with multiple currencies. This is particularly useful to any company that has a presence in multiple countries or that gets paid in different currencies

Supports currency conversion rates

The ability to define multiple conversion rates between different currencies. The feature facilitates generating reports in multiple currencies.

Support automated currency conversion rates updates

Capability to automatically update the conversion rates by connecting for example to an updated foreign exchange source and retrieving most up to date data automatically and without human intervention

Web interface with Ajax

Ability to access (update/retrieve) ERP data using a web interface that is user-friendly and interractive

Ability to define multiple custom workflows

Ability to define how the ERP data is manipulated by different stakeholders within the organization. Custom workflows is one of the major features that makes an ERP flexible and adaptable to an organization's structure and processes out of the box

Supports the creation of custom form fields on the fly through the interface

Ability to customize the user interface to receive new type of data to be stored in the ERP database. Accepting new types of data usually requires additional development, but some ERP systems integrate the possibility of customizing the data inflow through the user interface itself

Accepts substitute products

Possibility of defining substitute products in case one of the items was out of stock. This is particularly useful for BOM or procurement management, which allows to automatically replace missing products with alternatives without human intervention

Ability to define flexible product types

Capability of defining flexible products. Some ERP systems have a predefined set of fields out of the box, while others allow the creation of custom product properties

Capability to define custom invoice schedule for different customers

Different customers may need to be invoiced using non-standard terms. This capability allows defining multiple invoice schedules and assigning different schedules to different customers as needed

Define custom payment terms for each customer

Different customers may need to be assigned non-standard payment terms. This capability allows defining multiple payment terms and assigning different terms to different customers as needed

Capability to define custom volume discounts for each customer

Different customers may benefit from different discount terms. This capability allows defining multiple discount terms and assigning different terms to different customers as needed

Capability to define custom Units of Measures (UOM) for each products/service

Different product quantities are measured differently (in litters, Kgs, meters, custom pack size etc..) This capability allows defining custom units of measure and assigning it to products

Goods tracking

Allows the tracking of goods as they move around different stocks, inventories, warehouses and the supply chain in general. Each material, product, equipment can be located at any instant

Employee expenses tracking and reporting

Capability of keeping track of employee expenses and claims

Funds transfer and fund management

Capability of keeping track of cash movement between different company accounts and ability of managing funds and bank accounts through the ERP's interface.

Budget management

Ability of keeping track of budget projections through the organization's departments and projects

Asset management

Ability of managing assets, their location, depreciation, maintenance, through a single ERP interface

Document management

Capability of utilizing the ERP system for the purpose of managing documents and appropriately sharing them amongst the ERP system's users

HR employee holidays and abscence management

Capability of keeping track of employee holidays and abscenses. Normally includes features for manager approval and recurrent reporting

Point of Sale

Software that is installed at sales locations and that facilitates the management and tracking of product sales.

Time and task management

Capability of managing resource times. This feature is usually associated with the project management modules and allows managing the time of resources and how it is being spread over different projects, in addition to the ability of managing the different tasks that are assigned to resources

Ability to define custom views to show system data

Capability which allows the definition of new screen on the user interface that will allow the retrieval and aggregation of data types that are not normally displayed in that particular way. This is a feature useful of powerful reporting and easy access to the information available in the ERP database

Ability to define new custom database objects through the user interface

Gives the user the ability to define new database fields and associations without the knowledge of a particular programming language

Define department structures and management structures

Gives the ability to define the organization's hierarchical structure and keeping track of different departments and divisions and their associated stakeholders

Module management interface

A user interface that facilitates the management of modules (enabling / disabling / configuration) without any programming knowledge

Inbuilt chat utility

Ability to interact and message other ERP users through the ERP interface itself

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