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A THEORETICAL ANALYSIS OF KEY POINTS WHEN CHOOSING OPEN SOURCE ERP SYSTEMS

UMA ANÁLISE TEÓRICA DOS PRINCIPAIS TÓPICOS PARA A ESCOLHA DE SISTEMAS ERP OPEN SOURCE

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ABSTRACT

The present work is aimed at presenting a theoretical analysis of the main features of Open Source ERP systems, herein identified as success technical factors, in order to contribute to the establishment of parameters to be used in decision-making processes when choosing a system which fulfills the organization´s needs. Initially, the life cycle of ERP systems is contextualized, highlighting the features of Open Source ERP systems. As a result, it was verified that, when carefully analyzed, these systems need further attention regarding issues of project continuity and maturity, structure, transparency, updating frequency, and support, all of which are inherent to the reality of this type of software. Nevertheless, advantages were observed in what concerns flexibility, costs, and non-discontinuity as benefits. The main goal is to broaden the discussion about the adoption of Open Source ERP systems.

Keywords: Management Integrated Systems, Open Source ERP Systems, Information Systems, Information Technology, Business Management

RESUMO

O artigo apresenta uma análise teórica, baseada em uma revisão da literatura das principais características presentes em sistemas ERP *Open Source* a fim de contribuir com a análise de parâmetros que possam ser utilizados para a tomada de decisão na escolha pelo sistema mais adequado às necessidades da Organização. Para isso, contextualiza-se o ciclo de vida dos sistemas ERP, destacando as características dos sistemas ERPs *Open Source*. Como resultado, constatou-se que ERPs *Open Source*, quando analisados com cuidado, carecem de especial atenção às questões ligadas à continuidade e maturidade do projeto, estrutura, transparência,

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frequência de atualizações e suporte oferecido, sendo fatores exclusivos tangentes à realidade destes softwares. Não obstante, vantagens com relação à flexibilidade, custos e a não descontinuidade do projeto são benefícios percebidos pelos mesmos. O principal objetivo deste artigo é ampliar a discussão sobre a adoção de sistemas ERP *Open Source*.

Palavras-Chaves: Sistemas ERPs *Open Source* – Sistemas de Informação – Tecnologia da Informação - Administração de Empresas

1 INTRODUCTION

Over the last decades, company computerization has grown as an irreversible phenomenon and supported world globalization presenting social, economical, political and cultural integration. In this manner, lower costs and agility of Communication Information Technologies (CITs) were given rise due to the use of these tools in large scale by companies and also because business competition has became fierce nowadays in free market (Castro, 2005).

In general, Information Systems (IS) have developed some variables aiming at operational, managing, strategic, and sales/business purposes, by the information exchange ease of use. Stallings (2009) explains that nowadays information communications and computer networking have become essential to the business functions, whatever its size. Furthermore, both management and staff must be in a deep touch with these technologies so that they can assess needs and manage the systems.

Despite the technological development, it is necessary to adopt a solid process of choosing solutions by the organization. This process is to analyze from tangible aspects (such as cost reduction and profit increase) to intangible ones, such as process standardization, establishment of connections between suppliers and partners, and the possibility of stagger, among others, so that potential advantages to be enjoyed do not turn into traumatic processes from a financial and managerial point of view (Souza & Saccol, 2003).

According to Jacobs & Weston (2007), in the mid-1970s plenty of software companies were established with the purpose of developing standard software for integrated business solutions. Some of these developers “saw the need for pre-packaged enterprise technology solutions as an alternative to customized business software applications”.

Souza & Saccol (2003) characterize ERP as software able to integrate information related to business processes across the companies, and is one of the main tools responsible for such an integration. O’Brien & Marakas (2007) exemplify this integration regarding processing and tracking of data on stock, invoicing, schedule for raw material consumption, and human resources, among others. Both authors, as well as Laudon & Laudon (2007), point out their composition by units/packages.

Besides the classification as ISs subtypes, ERP systems may or may not be private software, and may have an open or closed source code in addition to other features possible to be classified.

In this context, Gacek & Arief (2004) state that the term “open source” is applied to software development projects based on the contribution of several geographically dispersed collaborators, but who maintain an online contact with the project. The

primary requirement for the feasibility of a project accepted as Open Source is its source code to be available for change.

Thus, Open Source ERP Systems is increasingly accepted by the general market, and one of the reasons is cost and the perception by the companies that customizations is an undeniable factor in any ERP performance and maintenance. The options of open code tend to be one step ahead of the private ones, since they offer unlimited access to the system core (Carvalho & Campos, 2006).). However, it is important to highlight that some definitions state that, according to the kind of license, it is possible or not to modify the source code.

Also according to Carvalho & Campos (2006), there is a number of options of Open Source ERP in the market, presenting different levels of project maturity, different sizes of database, features, and technologies and so on. According to Serrano & Sarriegi (2006), both Open Source ERP and owners involve complex implementation processes in which software and companies are strange to changes during the processes.

Therefore, when considering the existence of many options available and their distinction for proprietary solutions, the present work is justified, as well as its purpose of performing a literature review on features inherent to the Open Source ERP systems; thus, characterizing important factors of success in order to promote the discussion about and assist in the decision-making process of companies which intend to implement this type of system as well as warning against possible obstacles they may face.

2 METHODOLOGY

According to Sampieri (2006, p. 54), a literature review consists of "identifying, obtaining and consulting the bibliography of any other material […] from which is extracted and re-compiled relevant and necessary information". The present study was carried out according to the model proposed by the author in order to perform a qualitative and explanatory literature review. It was made the characterization and analysis of the main characteristics to be studied when comparing Open Source ERP among them, also considering their peculiarities before their proprietary options. The basic frame of reference for the characterization and analysis was defined from studies conducted by Correa (2008), Castro (2006), Szitas (2004) and mainly Herzog (2006).

The importance of such a work is to group and synthesize the main concepts related to the issue, thus supplying a unified frame of reference, which is specially justified because the subject is emergent and there is little research conducted. Furthermore, even if all concepts are not fully covered in their context, it is an initial source of research and discussion about the topic.

To reach the proposed objectives, this present work is organized as follow: section 3 contextualizes ERP systems in general lines, highlighting the main issues related to their use and implementation. Section 4 presents the context of the Open Source ERP system, characterizing basic concepts to discuss the features presented in section 5, which analyzes six classification macro-areas. The general discussion about the Open Source ERP is in section 6, and finally, in section 7 it is presented some conclusions and final considerations about the work.

3 CONCEPTS Of ERP SYSTEMS

According to Norris et al (2001, p. XXI), what is currently known as ERP is "the last of several production, finance and manufacturing information systems […] to improve the information flow running in parallel with physical assets […] immediately above and under the supply chain". Corrêa (2007) explains that MRP (*Manufacturing Resource Planning*) is a system to calculate the need of materials in order to offer management support.

Norris et al. (2001) emphasize that in the 1980's, there were lots of research and efforts related to the MRP system in order to make it applicable to generate information and support other modules and functions, then renamed as MRP II. Nevertheless, throughout the 1990's, specialists in software development created a system (or a "suite" containing several modules) capable of linking several internal areas of a company, named ERP.

Davenport (2002) highlights that although ERP is considered as an evolution of MRP and MRPII systems, it overcomes these expectations into a broader and more complex reality than a simple analysis of information needs and organizational integration.

Laudon & Laudon (2007) state that this suite, containing integrated software modules, is based on a simple database, centralizing the gathering of information processes such as production, finances, accounting, and marketing, among others. According to the authors, this great amount of data would be available to be applied to a myriad of intra-organizational areas.

According to Souza (2001, p.1) the significant growth in the use of ERPs is caused the competitive pressure of the market.

> *Companies recognized the need to better coordinate the activities of their value chains aiming at eliminating the waste of resources , reducing costs, and improving the time to respond to changes of the market needs.*

O'Brien & Marakas (2007) mention the main benefits offered by companies using ERP systems are increasing in terms of quality and efficiency in processes, cost reduction, support to decision-making phases, and better enterprise agility. Souza & Saccol (2003, p. 21) also explain that regardless of the few quantitative analyses carried out so far, it is noticed the companies present "cuts in raw material stocks, reduction of time to fulfill orders, production deadlines and bills receivables, besides efficiency in eliminating hand-performed operations".

The authors also mention that the availability of online information theoretically "contributes to the improvement of decision-making processes in companies using it".

In what concerns reduction of stock volume, Laudon & Laudon (2007, p. 45) explain that once there is integration among order, production and goods deliver systems…

> […] the production area is able to produce only what was ordered by clients, buy the exact number of components and raw material, plan the production, and reduce the stock time of components or final products.

Laudon & Laudon (2007) also emphasize that the possible generation of value by integrated systems of large organizations which have many geographically remote

operational units; therefore, they use the system so their businesses, practices and processes are executed in a homogeneous and standardized manner, no matter how far one unit is from the other.

According to Inside-ERP (2008), since ERPs are linked to several areas of the company, their benefits are beyond the tangible reduction of costs. The intangible benefits are noticed in the reduction of time to solve problems, viability of connection among several branches, standardization and acceleration of organizational processes, and better affiliation among company, partners and suppliers.

3.1 ERP problems related to the use and implementation

Despite the tangible and intangible advantages above, it is necessary to highlight possible problems resulting from using or implementing ERP. According to Souza (2000), a major issue related to its use is presented in the implementation phase, which can take three years to conclude due to the impact of the processes change performed by the company which generally presents hierarchic and departmental approach before the process-oriented view the ERPs present. Souza (2000, p.51) also mentions:

> *Due to the complexity of the process, it is stated as critical factor to implement ERP systems the total commitment of top management […] when using their results, transference of responsibilities for the success of the project to user areas, training and communication.*

In research carried out by specialists who used private systems, Themistocleous et al. (2001) point the main problems faced throughout the implementation process: budget over the previously planned (66%) and delay of schedule (58%). His work also establishes a relation of cause and effect between cost and time in solving problems, which involves internal and external factors of the company (conflict with consultants or staff, company strategy and sellers, general internal issues). From a technical standpoint, 82% of the interviewed people reported problems to integrate with systems already existent in the company, and 72% faced difficulties when customizing systems.

Although few companies admit, implementations are not well succeeded directly due to poor management, besides problems involving users and technical difficulties. Krasner (2000, apud Benesh 1999, p.38-43) mentions five areas commonly faulty during management processes: integrated planning of the project team, management of communication with large groups of people, formal decision-making process, and integrated test plan to consider the Know-how practiced in previous implementations.

4 OPEN SOURCE ERP SYSTEMS

As stated above, Gacek & Arief (2004) declare that the term “open source” is applied to projects of software development based on the contribution of several collaborators geographically dispersed but keeping online contact with the project. The basic requirement for the feasibility of an Open Source project is to make its source code available. Regarding the term definition, the authors refer to an “Open Source Initiative” (OSI), highlighting three basic aspects of the definition: free software distribution, access to the source code, and right to create derivative work.

According to OSI website (http://www.opensource.org), “is the stewards of the Open Source Definition and the community-recognized body for reviewing and

approving licenses as Open Source Definition-conformant". Their main goal is act as a charter institution and to prevent misuse of the Open Source term. Another important institution for Open Source universe is the Free Software Foundation (FSF), whose goals are to promote the development and use of free software by maintain the Free Software Definition and enforcing the General Public License (GPL) when copyright infringement occurs. There are five licensing classifications in Open Source universe, the first three according to FSF and the last two according to OSI.

The GPL declares that everyone can have access to the source code and any derived work can only be distributed under the same license terms. Besides this, you can execute the software, study, adapt and distribute its source code. There are three classification groups of GPL: Open Source Software under the GPL; Open Source Software - not under the GPL; Not Open Source Software. The OSI defines that there is just Open Source Software and Not Open Source Software.

In this context, the Open Source ERP systems have been increasingly accepted by the market in general. Some reasons are the low costs and the perception the companies perception that customization is an undeniable constant in the implementation of projects and ERP maintenance. In this subject, the option of open code surpasses the private one, since they offer facility for updates and faster bug fixes (Carvalho & Campos, 2006). It is noticed that many companies now accept the level of quality presented by these low cost technological solutions as an alternative to manage corporative environments

Finally, Herzog (2006) declares that this type of solution is frequently targeted by companies whose organizational and flexibility requirements are not covered by private packages. Similar scenarios are found in companies demanding ongoing adaptation of highly variable processes.

4.1. Reasons to open source ERP usage

According to Serrano & Sarriegi (2006), both Open Source ERPs and owners involve complex implementation processes in which companies and software are not familiar to changes in their processes. This mutual adaptation generally involves consultancy companies so that processes are less traumatic and less costly in what regards time and money. The authors also point that the benefits when choosing Open Source Systems are more substantial due to:

- Better adaptability: due to the availability of the software source code and its free manipulation, the customization tends to be easier. Thus, the need to customize it according to local laws and the company peculiarities, among others, are always necessary, independent of the area of work.
- Minimum supplier dependency: once a private solution is achieved, the company will be a "hostage" of the company which owns the project. Therefore, in case the owner leaves the project or the market, the continuity of the updating and maintenance of the ERP on the client company may be seriously jeopardized, since it will not have access to the source code of the software. Raymond (2003) suggests, regarding the closed source applications, that the more critical and vital the software is for a business, the less it will tolerate being controlled by an outside party. So almost no software consumer will choose to lock himself/herself into a suppler-controlled monopoly.

- Cost reduction: the Open Source ERP has no costs on license acquisition and usually does not need expensive equipment to be nicely performed. However Bozman et al. (2002) plead that comparing the total costs of ownership is the fairest way to confront costs, not only caring about the software acquisition.

Hexsel (2002) contributes with another point of view arguing about the low social cost. While the private software development is oriented to create benefits to the manufacturer, the Open Source Software aims to benefit its user. Furthermore, there is a phenomenon called software bloat; it happens when the private manufacturer develops new functions that will be useful only for a few users, these new capacities are commonly just perfunctory. Therefore the software tends to offer a lot of functions with limited usefulness for the most users.

According to Carvalho & Campos (2006), once the customizations are understood as necessary, the adoption of Open Source solutions are the best option to be chosen. The use of this software is competitively advantageous due to the integration it provides, it is fair to use its characteristics to obtain advantages greater than their competitors.

5. IMPORTANT TOPICS FOR THE OPEN SOURCE ERP SYSTEMS SELECTION

When the Open Source platform is chosen as a starting point to the ERP to be chosen, it is necessary to perform a comprehensive analysis of the features intrinsic to each software in order to choose the best option, according to Carvalho and Campos (2009). Herzog (2006) divides these features into five macro-areas: functional fit, flexibility, support, continuity, and maturity, which will be discussed in more detail.

5.1. Functional Fit

Functional fit is the level the ERP system fits into the specific processes of the company. The use of this term is more advisable than simply functionality. There are more possibilities of adjustments, less customization to be implemented and, consequently, lower costs. Besides, there are growing chances of the system to meet the managerial needs of the company. The functional adjustment also has great impact on the total cost and execution time. Our work is not focused on showing techniques to measure functionality, but Herzog (2006) indicates that the total number of tables on the database can be considered a measurement factor.

Reinforcing Herzog´s point of view, related to the importance to analyze functional adjustment, Correa (2008, p.96) reflects on the fact that in private ERPs, due to years of evolution, there is a great number of better practice processes available. In some Open Source solutions there are only “basic processes available, such as purchase orders, sales, stock, bills receivable, and accounting, among others”. The author also highlights specific cases of companies with highly customized processes, and few of them benefited by the existence of “better practices” in the system, which does not justify the cost of adopting private solutions.

According to Carvalho (2006, p. 5) the adopter of strategic positioning has a great impact on the way they see ERP; so, “different kinds of adopters may assess an identical project feature quite differently”. The author interprets the functional fit question

splitting the Open Source ERP adopters in two groups, the Consumer and the Prosumers.

The Consumer would have "a passive role where the adopter will simply buy the adapting service from a software house, without any direct collaboration in the development process" while the Prosumer has "an active role where the adopter will assume the adoption process, reporting bugs, […] providing bug fixes, patches, and new features or even modules". Moreover, Carvalho (2006) points out that is important to evaluate if the adopter´s IT team has the knowledge and availability necessary to develop new features and, if so, costs and time must be addressed to the project. Therefore, while analyzing the functional fit question and the missing technical features or functionalities, the adopter must decide if they will become a developer or the software weakness will exclude ERP from the selection board.

5.2. Flexibility

Flexibility allows overcoming the disparity between private solutions and systems totally customized to clients. Besides the possibility of adapting the software to the needs of a company, flexibility also implies issues such as ease of use. management and platforms independency. An ERP considered flexible must satisfy the criteria presented in Table 1 (Herzog, 2006). Lv & Chen (2010, p. 627) verify the flexibility´s importance "when our business process is highly variable and complicated, or we have to adjust system frequently".

Characteristic	Description
Customization	Introduction of modifications and adaptations to the software in order to achieve expected behavior and functions.
Flexible upgrades	Upgrades do not cause impact on the customizations previously implemented
Internationalization	Support to several languages, and finance and accounting schemes
Friendly interface	Ease of use and learn when handling the system.
Architecture	Software components and their interfaces
Scalability	Support to expansion of users and data base.
Security	Possibility to define levels of access
Interface	Data exchange between different software
Operating system (independency)	Enables the execution in several platforms
Database (independency)	Enables the execution in several databases
Programming language	The programming language used to implement the source code.

Table 1 – Characteristic related to the project flexibility

Source: Adapted from Herzog (2006)

Based on the criteria presented in Table 1, but in a more detailed view, customization can be analyzed considering two categories. First, high level customization, when there is the possibility of editing metadata. In this manner, it is possible to personalize the system by means of an interface instead of a direct contact with the source code. The purpose is to reduce the time of learning and overcome a myriad of possible problems. Thus, a powerful interface of high level customization is

an important factor regarding productivity and reduction of implementation time, thus enabling an ongoing adaptations process. In turn, low level customization is when there is a direct contact with the source code program, enabling to meet the pinnacle of the system modeling to what the company needs.

Also in what concerns customizations applied to ERP, whether made in high or low level, upgrades previously or later installed may not be impacted. In this manner, they do not have to create the need of further customizations.

Another factor to be analyzed is the internationalization of the system. It is worthwhile the fact it offers support to several languages and finance and accounting schemes. For instance, there are different manners to make translation available, both for graphic interface (menu, fields to insert data, etc) and content (product description, for instance). Campos (2006) highlights the need to verify the real support of languages by the software. In his research, the author reports that although some systems mention the support to the Portuguese language, it could not be completely implemented or be available only in some specific versions.

Hau & Aparício (2008) list some points about software internationalization beyond the language translation alone: date and time format; currency format; alphabets, numerals, and left-to-right script vs. right-to-left; language character coding sets for textual display; name and titles; sorting of name and text; telephone numbers, addresses and international postal codes; weights and measures; accounting models, taxation models.

Graphical interface must be developed according to the required information, that is, a single task must not require navigation by means of a great number of different screens. A friendly interface is intrinsically attached to customizations possibilities, acceptance by the user, and costs with training and operation.

Szitas (2004) synthesizes the user friendliness aspects in some requirements: Simplicity/Clear Interface (the user friendly interface can help to reduce the resistance of employees against the installation of a new system); Easy access and usability; Intelligibility (includes tools making it possible for the unqualified users to easily navigate the system, for example, “wizards”); Flexibility (the interface must be flexible and configurable according to the user’s needs); More interfaces (distinct interfaces for different user´s levels of knowledge); Thin client (the user interface should be independent of the application task as much as possible).

Calisir & Calisir (2004, p. 7) conclude, after studying data from 51 ERP end-users, that learnability and the perceived usefulness are determinant to the end-user satisfaction. As an example, Calisir & Calisir (2004, apud Thong et al. 2002) say that “broad and shallow menu structures should be preferred to narrow and deep ones. The removal of unnecessary or redundant screens will also help to keep the navigation flow uncomplicated.”

In addition to that, the term interface also refers to the communication of the software with other systems and its data exchange with them. Such a possibility is called Enterprise Application Integration (Herzog, 2006, apud Alshawi et al. 2004, p. 454-462), and it standardizes these information exchanges in order to mechanize the practice among third parties, which can make the integration process easier.

Campos (2006) exemplifies this data exchange in a scenario where the user intends to export/import data from an electronic spreadsheet to the ERP. In case the system offers native support to files in some desired formats, it is possible to save work hours spent on manual data transfer. However, in case the system does not offer such a support, the employee and the IT team loses time to create a solution. The time spent to develop such a solution depends on the type of interface used by the software. The author also mentions the importance to exchange information with other programs such as text editors or e-mails senders.

An important topic to consider when choosing the Open Source system is its architecture, in 2 or 3 layers. A two-layer structure consists of a data base and an application executed directly by the client. In the case of a three-layer application, the client executes only the user interface and a simple verification of data, thus processing less information, while the server executes the whole logic programming. Also from the perspective of the adopted architecture, Correa (2008) observes whether or not there is access to the system by means of the internet, and such functionality is desirable by some companies.

Scalability is an important factor to be considered, especially in what regards medium and long term horizons. It depends on the architecture (the three-layer is the most indicated), besides the technology of the database chosen. It is considered scalable the system able to expand (in number of machines and number of users supported) with minimum performance loss. Correa (2008) supports that solutions developed internally in the company present limitations regarding the issue, while Open Source or private solutions do not require such a limitation.

From the security standpoint, the system must enable the definition of several and different levels of access rights. Besides, users are able to only visualize the transactions/information they are responsible for. Campos (2006) questions other major factors to be considered as to the existence of security resources such as use of passwords, cryptography, and the security offered by the management of the data base and backups. Arguing about the safety and security, Szitas (2004, p. 466) says that the database, whose importance will be discussed below, is “probably the most critical part of the ERP”. Because “expropriating this can be invaluable for the competitor and, on the other hand, its possible damage can paralyze the company

The independency of the operating systems (OSs) and databases is an especially important issue from the standpoint of the user and from scalability. ERP can be executed from the most different OSs, giving the company more freedom to what concerns IT strategies. The operating system Independence is also discussed by Szitas (2004, p. 465) exalting the portability in the “modern software engineering nowadays”. About the platform-independence Szitas (2004) also says “this can be achieved by developing the user interface in a platform-independent way (e.g. in Java) or by using a standard protocol (such as HTPP, namely the web environment).”

As stated above, the database also influences the system scalability, but it is necessary to highlight there is a win-loss relation, once such an independency implies to reject the use of characteristics inherent to certain databases in order to achieve support to a greater number of technologies. However, it is highlighted that some of these rejected characteristics can be implemented in their own application by means of programming.

Campos (2006) remembers the importance of the free choice for a database, especially in the case of companies which already have recorded data and need to use it in the new system. Baharum & Hibibollah Haron (2009) have determined several critical factors to ensure the success of an Open Source ERP Implementation. The database migration is one of these factors because of the great importance of converting company´s data from older to a new data management system.

Finally, the analysis of the programming language used in the ERP coding is a criterion directly linked to the issue of low level customization. According to Prechelt (2000), in his comparative study, the programming languages C++, Python and Perl are efficient enough when using not much memory, while Java is less efficient in this case. Regarding the number of lines to be programmed to achieve the same result, C, C++ and Java need more extensive codes, opposing to Perl and Pyhton. Also considering lines to be programmed, C, C++ and Java are the programming languages which require the most time to build a standard program, while Perl and Python require less time.

5.3. Support

Support has contributed to decrease the time of implementation by transferring knowledge to the company, thus helping to develop internal activities or engaging external consultants to implement and maintain an Open Source System. Table 2 presents the major characteristics to be analyzed in this topic.

Reliance on the support offered to the system is an important topic to be evaluated. Most ERP open source systems have problems to be solved by means of a contact network, which can be compounded by internet forums, and e-mail discussion lists, among other online resources, to contribute to the discussion about the system and its development. Expert consultants and representatives of the system are another support tool.

Characteristics	Description
Infra-structure	Physical, virtual and phone channels available to solve problems
Training	Availability of courses and certifications applied by the supplier company or third parties.
Documents	Complete and updated literature which satisfies all levels of information required by users and developers

Table 2 – Characteristics related to the project support

Source: Adapted from Herzog (2006)

The quality and the frequency of technical training to users and regular organization of events related to the software must be analyzed.

The comprehension and update of documents directed to users and developers are paramount, and a number of projects use Wiki interface to manage collaborative systems of support and information.

5.4. Continuity

Continuity (Table 3) guarantees that the project is not abandoned, and in case it is, the organization IT team is able to continue developing it according to the need of the company. Unlike private systems, a consolidated Open Source ERP is rarely abandoned, since there are companies and online communities contributing to its development. However, when the project is managed by only one company, there is the risk that several versions of the system are published under different types of licenses different from the initially followed.

Nevertheless, in the case of Open Source systems, companies hold a small power to take hostile decisions as for the project gratuity, since there is the possibility of diversion of what the company preaches and what the community wants. Companies managing Open Source projects are highly dependent since they have an active community and only a small part of clients is interested in buying additional services.

The communities involved in developing the Open Source ERP, besides characterized by size and activity, can also be classified into four categories applied to the development of the systems according to Herzog (2006): virtual user who is active in forums, *beta testers* which identify bugs, creators of documents, systems developers. The bigger and more active the community is, the smaller the chances of abandoning the project. In case the project is hosted in some online environment of software development (SourceForge, for instance), it is possible to make a thorough analysis of the community, once the platform offers statistics and indicators about the project; this data can be questioned due to bad practices of the organization inside an online community. Table 3 shows a summary of the main characteristics related to the continuity of Open Source projects.

The projects may be headed by communities or private companies which orientate them. Whenever there is a company in charge of the project, it means it is responsible for its development for supplying related services and certifying partners for local support. A typical project headed by a private company comprehends the following agents: a private company in charge of the project, companies which are partners in the project, clients with a support agreement, clients with no support agreement, and users utilizing the systems. The business model and the size of the company heading the project are indicators of continuity. Finally, in what regards the projects directed by companies, it is highlighted that the contributions for their source code can be develop by the community involved and by partner companies

Characteristics	Description
Project Structure	*Open Source* ERP Project can be conducted by companies or communities
Community activity	Follows the level of contribution of the members
Transparency	Barrier to the new developers' entrance, as well as the possibility they have to influence the developing project.
Update frequency	Analyzes the frequency of the updates
Further factors	External factors possible to influence continuity

Table 3 – Characteristics related to the project continuity

Source: Adapted from Herzog (2006)

It is comprehended that in projects exclusively directed by a community, there is no companies financing them in special. While the size of a community is not a measurable factor, its activity is partly measurable. Besides considering the number of exchange messages, it is necessary to evaluate the time of delay between a question and its respective answer. The activity in areas such as document creation and new entries to wiki platforms must be considered.

Factors such as barriers to the entry of new developers, degrees of liberty and influence that the community is able to exert over the system development are inherent to the transparency of the project according to Herzog (2006). It is also highlighted the importance of the existence of the development scheme of the system´s documents, so that the current focus and future direction of the projects are noticed.

In what concerns the software source code, it is desirable it is meticulously documented with its logs and written in a manner that makes the programming easier to understand. Stamelos et al. (2002) propose a method to measure Open Source code quality, one of the metric components is the comments frequency inside the code. Xu (2003) explains that comments are a general rule of good programing, while the code shows "how" to complete a task, the programming codes show "why" the task should be completed this way.

The ongoing introduction of new functionalities and correction of the system errors are solid evidence of the project activity. Communication is related to the community activity while the regular update is related the system development/activity.

There are other factors to influence the continuity of the project. As previously addressed on "Flexibility", the independency related to operating systems, databases, utilization of other parallel Open Source projects and dependency on technologies or proprietary components can negatively or positively influence this aspect.

5.5. Maturity

Finally, maturity is a concept related to the quality of software (number of bugs, level of execution and test time, among others). Table 4 presents the related characteristics:

Characteristics	Description
Development Status	Level of development (from planning to final commercial versions of the software)
References	Literature of several sources reporting experiences, tests, and discussions

Table 4 – Characteristics related to the project maturity

Source: Adapted from Herzog (2006)

In general, software is categorized by its own development stages (Herzog, 2006): planning, alpha, beta, and stable. The phase of planning means there is no executable program available yet, while the first version is executable and denominated "alpha", which is generally unstable and incomplete, but used for demonstrations and suitable as a demonstration prototype.

The beta version consists of software still under development and available for tests. After extensive tests and correction of primary bugs, the program can be considered a stable version, since there are only minor and permitted faults which do not harm its major functions.

Software can have its maturity status testified by the occurrence of discussions in forums, published tests by professional people and renowned companies, besides reviews exploring its faults and virtues. In this manner, it is possible to better know the system behavior in real situations before experiencing it in the company.

6 REMARKS ABOUT THE USE OF OPEN SOURCE ERP

According to Inside-ERP (2008, apud Aberdeen Group Inc. 2007), the total cost to acquire a private ERP comprehends factors such as size of the company, number of users of the system, depth and scope of functionalities, and benefits, among others. In this manner, this cost can be up to millions of dollars, which is prohibitive to several organizations. In this scenario, many mid-sized companies prioritize, as main points when choosing a private package, its acquisition cost and functional characteristics to the detriment of other important and above mentioned factors.

It is emphasized that due to the high costs of private solutions, initially, they were concentrated on large companies. However, after going through this cycle, the market of mid and small companies was also focused. According to Watson (2007), this flow meets the case of the Open Source ERPs, once they have been adopted by mid and small companies firstly. The costs involved in the case of Open Source solutions, in a simplified way, are the purchase of hardware equipment, training of staff, and organization of a technical team able to implement and customize them in case such tasks are not performed by an outsource company.

Nevertheless, it is worthy reflecting about a long term horizon in what concerns costs. Private ERPs offer specialized staff and support, but Open Source solutions headed by private companies are also able to offer such a level of certification. In general, according to what was proposed, Open Source ERPs require more modest hardware, which must be taken into account in what concerns future stagger and company growth.

In what concerns flexibility, Open Source solutions are more flexible than private ERPs, since their nature are not originally flexible, adapted to accept certain customizations, parameterizations, and flexibilities partially limited by the user. It is emphasized the need of some companies to adapt to the system due to its stiffening, which does not occur in case of Open Source solutions. It is also important to highlight that, regarding commercial packages, client companies are not completely familiar with the software core, occasionally requiring synergy and integration.

While private companies may fail or discontinue lines of software, it does not occur exactly to solutions directed by communities. In case the company adopting the system becomes little contributive or quit some projects, it can freely continue with the project.

However, like the commercial ERP software, the Open Source requires a very detailed selection process. It is paramount to align characteristics of the system with the

business strategy, making it a feasible tool for the organization to use. In this point, there are possible obstacles with low level of maturity in information technology.

Besides, attention must also be paid to the management of implementation. In the same context, a low level of maturity in information technology can lead the organization to fail when implementing the system, even if it was correctly chosen.

7 FINAL REMARKS

Once the philosophy of cooperation and free development are adopted, with no contract constraints imposed by private companies, it is possible to choose low cost solutions for implementation and licensing. Besides, there is no continuity of software lines (which force the clients to obtain new products) since the total development can be performed by the company itself.

These Open Source solutions are found in good number and present different characteristics, from the basics, such as support to languages to accounting regulations, beyond those that are highlighted in Eras et al. (2010). Since they have a different philosophy of project for private solutions, they present unique characteristics to be analyzed. Issues related to project continuity, activity degree, structure, transparency, and upgrade frequency are exclusive factors regarding the reality of this kind of software. However, project maturity and forms of technical support offered are also different in the manner they must be analyzed comparing to private solutions.

After the detailed analysis and comparison of the several characteristics presented, it is important to have a quick and low-cost implementation process development. In order to do so, the synergy of workgroup and effective training of the future system employees (Noudoostbeni et al., 2009) are indispensable, besides the full commitment of top management. It is emphasized that factors related to failure are ineffective planning of the implementation and insufficient training.

It is concluded that, in general, for mid and small companies or scenarios in which there is the need of frequent or deep software upgrade and customization, we believe the decision for an Open Source ERP system is highly acceptable. Therefore, following a detailed method of implementation and a choice which is focused and adapted to Open Source solutions (Mendes e Escrivão Filho; 2007), besides the focus on the factors here presented, as essential to the success of the project. Special attention to the factors related to failure must be paid as to the best choice to be made.

Regarding the limitations of this study, predominantly based on the literature review, legal, organizational, and cultural distinctions, among others from Brazil, are emphasized, in comparison to countries with the highest historical use of the software, focus of the study. We suggest for future work a statistical approach to the Brazilian companies that have had experiences with Open Source software management. Thus, a fairly accurate scenario of the reality is expected to be built about the domestic companies when considering technical factors which determine the success or lack of success of their choices in terms of systems..

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