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Maintenance and Support Model within the ERP Systems Lifecycle: Action Research in an Implementer Company

António Amado^a, Fernando Paulo Belfo^{a,b,*}

^aCoimbra Business School – ISCAC, Polytechnic Institute of Coimbra Quinta Agrícola, Bencanta, 3045-231 Coimbra, Portugal

^bCentro Algoritmi, University of Minho, Campus Azurém, 4800-058 Guimarães, Portugal

Abstract

Organizations continue to adopt ERP systems. It seems to be a way to increase efficiency and gain advantages over competitors. Traditionally, decision, selection, planning, and implementation phases were the focus of ERP systems lifecycle. However, main problems of several implementation failures were related to lack of customer support and adequate maintenance. This paper presents a proposal of a maintenance and support (M&S) model within ERP systems lifecycle which includes 4 support activities and 41 maintenance activities separated by 4 phases, respectively, problem and modification analysis, implementation of modification, revision and acceptance phase and migration. Differently from others, at this model, the support is autonomous from maintenance, evidencing its role between operation and maintenance. It is also presented an action research performed in an ERP implementer company where an evaluation of maturity level of all 45 M&S activities were made. The analysis of existing M&S practices in this company allowed to understand this implementer has significant weaknesses with 20% of its processes (9) not or poorly implemented, and therefore, presenting great opportunities for improvement. Some of these practices were discussed.

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* Corresponding author. Tel.: +351-239-802-000; fax: +351-239-445-445.

E-mail address: fpbelfo@gmail.com

1. Introduction

The adoption of ERP systems continues to be a way for organizations to gain competitive advantages over their competitors. Probably for this reason, it has been possible to verify that in the Europe there are increasing rates of adoption of ERP systems. In 2012, the adoption rate was around 22%, rising to 26% in 2013, 31% in 2014 and 36% in 2015. The growing adoption of ERP, whether proprietary or open source systems, implemented either in large or small or medium-sized companies (SMEs), continues to deserve investigation for their relevance. If, on the one hand, the ERP adoption is greater in large companies, on the other, it represents a great opportunity for SMEs. In Portugal, the ERP adoption ratio in 2014 also decreased with company size. Large companies had an adoption ratio of 90%, medium-sized companies around 60% and small companies registered an even lower adoption, close to 35% [1], [2].

Until recently, the focus of companies was essentially on systems' implementation phase and stages that precede it. However, after several installations failed, it was concluded that some of main problems were related to lack of customer support and adequate maintenance of the ERP system by providers. It started to be evident the importance of the maintenance stage, enhancing the realization of opportunities, namely cost reduction and service optimization, both for providers and customers. The maintenance and support (M&S) of information systems is, gradually, becoming more important, proving to be fundamental for their successful implementation. Furthermore, ERP differ significantly from other information systems, and M&S assume to be extremely important and crucial on these of systems [3].

This paper presents a literature review about ERP systems life cycle, specially, the maintenance and support stages. A life cycle model of ERP systems is proposed, focusing, and detailing maintenance and support stages and their interactions. Four phases are proposed for maintenance stage, including activities that will guarantee the success of each phase. It is also highlighted and discussed the role of support in the success of ERP system. Finally, an action research developed in an ERP implementer company in presented, including the evaluation of the level of maturity of all 45 maintenance and support activities proposed in that model. Results are discussed and conclusions are made.

2. The ERP Life Cycle

According to Souza and Zwicker [4], the life cycle of an ERP information system includes the decision, selection and planning stages, followed by the stages of implementation and use. The decision and selection stages occur through an interactive process with each other. In decision-making stage, the organization's requirements should be considered, which will help to define the project's objectives. The business requirements and the objectives of the project will be the basis for the selection stage, in which it is intended to reflect and clarify which ERP package to choose.

In decision and selection stages, it is essential to deepen the knowledge about each of the candidate ERP systems. Better knowledge about each ERP will clarify the possibilities and limitations of each product, which will be the basis for the decision stage. The deepening of knowledge about ERP systems candidates chosen by the organization is obtained through

Documentation provided by suppliers, demonstrations sponsored by them, articles, publications and professional visits to companies that already use these systems will allow to deepen knowledge about ERP systems candidates [4]. In selection stage, besides selecting an ERP package, it is defined which modules to implement and when this will take place. After decision and selection steps, a planning document should be prepared, describing the necessary human, financial, software and hardware resources for future successful implementation [4]. The implementation, the process in which modules of the ERP system are put into operation, is supported in the outlined plan [4].

According to O'Donnell [5], there are five steps to be followed in order to achieve a successful implementation. The first step consists of strategic planning, which involves the definition of a team for the project with employees from the various departments of the organization, in the analysis of current processes, in their possibility of improvement and in the associated information flows. This step also includes setting goals and drawing up a plan. The second step comprises the review of procedures, where the team must review possibilities of the software and try to identify gaps and evaluate possible automation of manual processes within the ERP. Operational procedures still need to be developed [5]. Then, third step involves the collection of previously used data, collection of new data and their conversion. Then, data must be loaded into the ERP, either manually or automatically, and cleaned, ensuring its accuracy and integrity [5]. The fourth step comprises training and testing. A pre-test of the database must also be performed, ensuring that planned tests cover various situations provided for in operational procedures. Someone from

the team should be the trainer, training other elements and minimizing the possibility of usage resistance by users. The project team will carry out final tests with previously defined data and processes. Depending on tests results, some adjustments to implementation may be made. The last step of implementation contemplates the start-up and evaluation of the solution. It also includes the development of a checklist of important aspects to be guaranteed before the start-up, such as ensuring the physical inventory is complete or that the implementer is completely available for start-up. Finally, a final evaluation must be carried out, according to the evaluation plan defined above.

Unlike O'Donnell's [5] approach to implementation, Souza and Zwicker's proposal [4] separates the utilization stage from the implementation stage, thus highlighting the iteration that occurs particularly between these two stages in the life cycle of an ERP system. In the utilization stage, the use and growth of the system by the organization must be monitored. It is usual that after the first implementation there are opportunities for improvement [6]. According to Souza and Zwicker, the utilization step will bring new knowledge, new needs or difficulties of use that had not been identified at the first implementation and that can be used to plan a new implementation stage. New organizational options may also imply the redefinition of the parameters previously established [4]. This iteration between the stages of use and implementation can, and should, occur in different phases throughout the life of the ERP system.

3. Maintenance and Support

According to Sommerville, maintenance is the process of making changes to a system after it has been put into operation [7]. Changes to a system may be complex. They may range from simple corrections of coding errors to wider changes, improving design or make significant improvements that allow correcting complex errors or accommodating new requirements. There are three types of maintenance: error correction, adaptation to the environment or functional addition [7]. The maintenance objectives include detection and correction of errors in existing software, an adaptation to external environment of the organization, an improvement of existing functionality, addition of new functionalities and the maintenance of the system, according to the requirements of the supplier. User support is often associated with the training of users and also with consultation, through user surveys, about the use and features existing in the system [8]. As the success of an implementation depends on the receptivity and behavior of users, the maintenance and support are increasingly becoming very important stages in an ERP life cycle. When users are not ready to change and adopt the ERP system, their behavior towards it will prevent them from working and resolving conflicts [9].

Support and maintenance practices are, increasingly, considered important for the successful adoption of an ERP system. The costs of maintaining an ERP system represent on average about 25% of the cost of its initial implementation and the costs of updating represent approximately between 25 to 33% of these initial costs [10].

A maintenance and support model will allow us to reflect on the procedures to be implemented, their planning and their possible problems, increasing the efficiency of this whole process. Celeste Ng, Guy Gable and Taizan Chan proposed a software maintenance model that covers three stages [10]. The first of these steps is the preparation of maintenance, which involves planning its management and the entire maintenance process. The second stage consists of the maintenance procedure itself, which covers the sequence of activities and tasks adopted, like the management, control, and execution of the maintenance request. The last step is software update, including important activities when updating an existing software with a new version. The benefits of using a maintenance model include having a support management tool, allowing a justification of costs and benefits, minimizing risks, the visibility of maintenance activities and tracking maintenance and progress [10]. It allows the organization to have knowledge of the processes to be developed during the maintenance preparation phase, the maintenance procedure, and the software update. It also facilitates management, showing that participation is essential not only in the initial implementation phase, but also in the maintenance phase, ensuring requirements, policies and processes in its various phases are met, defined and aligned with organization's business objectives. A M&S model gives visibility to maintenance and support activities, making it possible to carry out, in a more assertive way, the supervision, organization and management of these activities, allowing the minimization of maintenance costs. In addition, organizations can easily identify and organize the data to be collected throughout the preparation and the maintenance procedure, as well as the update. Finally, a model should allow the tracking of maintenance and its progress, enabling the use of the system as a methodology to prepare maintenance and update projects, initiate a request, track progress and finish a project [10].

Many companies that adopt ERP systems focus essentially on the implementation phases and processes, while neglecting the post-implementation processes, specifically the maintenance and support phases [3]. Good M&S

practices are fundamental for extending the life cycle of an ERP and stabilizing the system, to support business operations in the most efficient and effective way. These stages can be considered as essential for the critical success factors (CSF) of ERP adoption projects. Thus, the M&S stages must be included as key elements from beginning and throughout the software life cycle [3]. ERP maintenance differs not only at implementation activities, but also at traditional maintenance functions due to two characteristics of ERP systems. On the one hand, ERP are integrated systems and involve a larger number of different stakeholders, as a wide range of businesses areas, IT, customers or suppliers [11]. According to Ng, Gable and Chan, ERP maintenance can be divided into three functional categories based on the software maintenance rules [8]. One, corresponds to user support, which involves a wide variety of tasks, including answering questions with instructions, elaborating questions to users about using the system, solving user problems and analyzing system errors, also serving as the first contact for change requests, looking for errors, sending feedback to the supplier and also training users. This category requires not only technical knowledge, but also knowledge about work processes. Another category corresponds to changes in ERP, where ERP systems are continuously improved after implementation. The changes, induced by the customer, can result from changes in the business and organization strategy or technological changes. These changes may include modifications to existing features of the ERP system or improvements that provide new features for it [8]. A third category corresponds to ERP updates, usually, made by supplier or implementer, providing corrections or updates, as a response to the detection of anomalies or to meet customer needs. These updates correct errors in ERP functionalities or adapt the system to changes in the external environment, such as changes in government regulations [8].

Other functional categories proposed for ERP maintenance are corrective, adaptive and perfectionist maintenance [7], [12]. Corrective maintenance is used to correct errors in design, code, or implementation phases. Adaptive maintenance satisfies changes in data processing environment and to meet new user requirements. Perfectionist maintenance aims to improve efficiency, performance, or maintenance of processing, to better meet user requirements. Other authors proposed the preventive maintenance, which refers to periodic inspection of systems to anticipate problems. Another proposed category is user support, which focuses on requests from users associated with the consultancy and requests for user assistance related to the system's behavior, rules and functions [12].

Kung and Hsu identified four distinct software maintenance phases. They stressed that support is more demanding in first phase of maintenance, changes are more frequent in the second phase, the most common improvements in the third phase and replacement of technology is the main concern in the last phase of maintenance [13]. In the introduction phase, users are the same who were part of software development team. The present phase takes place in first months after implementation, and therefore the ERP usage is still low. In the growth phase, there is an increase in the use and acceptance of the system. If its usage is mandatory, it will lead to a better understanding of all its features, through the information transmitted between users. If it is voluntary, this phase will register an increase in the number of users due to positive results of first phase [13]. The maturity phase occurs after the system is stabilized. At this stage, the IS team witnesses the growth in requests for improvement. It is in the maturity phase that major improvement projects take place that test the limits of the technologies and software functionalities. Finally, in the decline phase, as the ERP system reaches the limits of the embedded technologies, users need to have their software renewed. Managers must choose between integrating ERP in other systems or developing new software, to replace the current one. To implement new technologies, organizations must expect declines in productivity when adopting these new technologies [13].

Maintenance and support issues are also addressed in some international standards. ISO/IEC 12207 standard establishes a common framework for software lifecycle processes, with well-defined terminology, which can be referenced by software industry. It applies to acquisition of software systems and products and services, supply, development, operation, maintenance and withdrawal of software products, performed internally or externally to an organization [14]. The ISO 14764 standard, properly framed with the ISO 12207 is another standard that specifically describes the process for managing and executing software maintenance activities [15].

4. ERP Systems Maintenance and Support Model Proposal

ERP system suppliers make new system versions with the aim of incorporating new features that can lead to an improvement in the performance of organizations. Maintenance can be agreed with implementer to take advantage of these new features to be made available when installing the new version. Based on the proposal by Souza and Zwicker [4], a new model for the ERP systems lifecycle, its stages and their interactions is proposed and illustrated in Fig. 1

(a). This new model values the maintenance and support phases and their specific interactions within the scope of the life cycle of ERP systems. This paper specifically covers maintenance and support stages, reinforces the relationship between stages of operation and maintenance, but not other stages of ERP lifecycle. The proposed model details are inspired in most previously referenced sources in this paper, particularly in ISO 14764 standard [15]. It proposes not only the life cycle stages of ERP systems and their interactions (a), but also the specific interactions of maintenance and support stages (b) and a detailed perspective of the maintenance stage, its phases, and activities (c). The maintenance stage has four phases, each one with several activities.

The first phase proposed is the analysis of the problem and the modification. The need for alignment is the issue addressed in this model. Vertical alignment is associated with the definition of an organization's strategy appropriate to an internal evaluation of the company, configuring strategies, objectives, action plans and decisions at the various levels of the organization. Another need for alignment is related to cross-functional integration, connoting the consistency of decisions through functions such as marketing, operations, human resources, complementing and supporting each other [16], [17], [18], [19]. Alignment has also been a dominant concern in the field of information systems, particularly in the implementation of ERP systems. For a long number of years, alignment remained one of the most important concerns among IT (information technology) managers [20], [21] [22]. Business and IT alignment can be defined as the "measure of how much the IT mission, objectives and support plans are supported by the business mission, objectives and plans" [23]. The belief that alignment contributes to better organizational performance must be the basis of the concern expressed consecutively around the alignment between business and IT. While organizational performance depends on a complex set of factors, it appears that aligning business and IT helps IT investments achieve greater returns, resulting in greater organizational performance. Many studies have essentially focused at the operational level of implementation. Some authors proposed that the implementation of ERP systems should consider different levels, respectively the strategic, tactical and operational level, searching their vertical alignment. These levels are not independent of each other, but each level should be used to support and derive the next level. Strategic level is associated with establishing general goals and planning how to achieve them [24]. At tactical level, it is intended to ensure company meets its goals, achieve objectives of senior management and that its resources are not wasted [24]. Operational level includes a set of implementation activities, such as business process modeling, system configuration or customization, final preparation and commissioning [24]. Alignment, like other organizational challenges, is essentially promoted by people, so implementing, maintaining and supporting an ERP system needs to focus on people and their incentives according to this alignment goal in mind [25], [26], [27]. This phase also contemplates the need to deepen the understanding of ERP system and processes that have to do with the modification. In this initial phase, the development of options and the analysis of the impact of these possible options are highlighted. If it is decided to proceed with the modification, it is necessary to plan the modification and formalize this approval.

The second phase is the implementation of modification. It is well portrayed and detailed in the implementation process proposed by ISO 12207 standard [14]. However, given the specificity of maintenance in ERP systems, there are particularities that are considered important to underline and add. Implementation must start with the elaboration of an evaluation plan and elaboration of a checklist that allows to later attest the success of the modification implementation. Elements to be modified, such as components or software units, interfaces, or documentation, should be identified. Then, possible change of the process associated with the system change should be considered. This possibility will depend on a critical analysis of the current process. The new version of the ERP system could probably include, for example, automation or elimination of some tasks in involved process. In addition, this new system version may include parameterizing or customizing the package. The first of these options is always preferable if the result is identical. This is because parameterization is, as a rule, a more economical and faster modification than customization. If the expected results of customization are significantly better than those from parameterization, than customization may be preferred. This phase should also include technical tests, ensuring supplier's code do not include errors or defects, functional tests to ensure that all features are covered as planned and documentation, as manuals, update.

The modification revision and acceptance should guarantee requirements traceability, recording the link between requirements and the steps preceding modification is completed. Furthermore, integration of the modified components in the system should be done, guaranteeing the functioning not only of the part, but also of the whole.

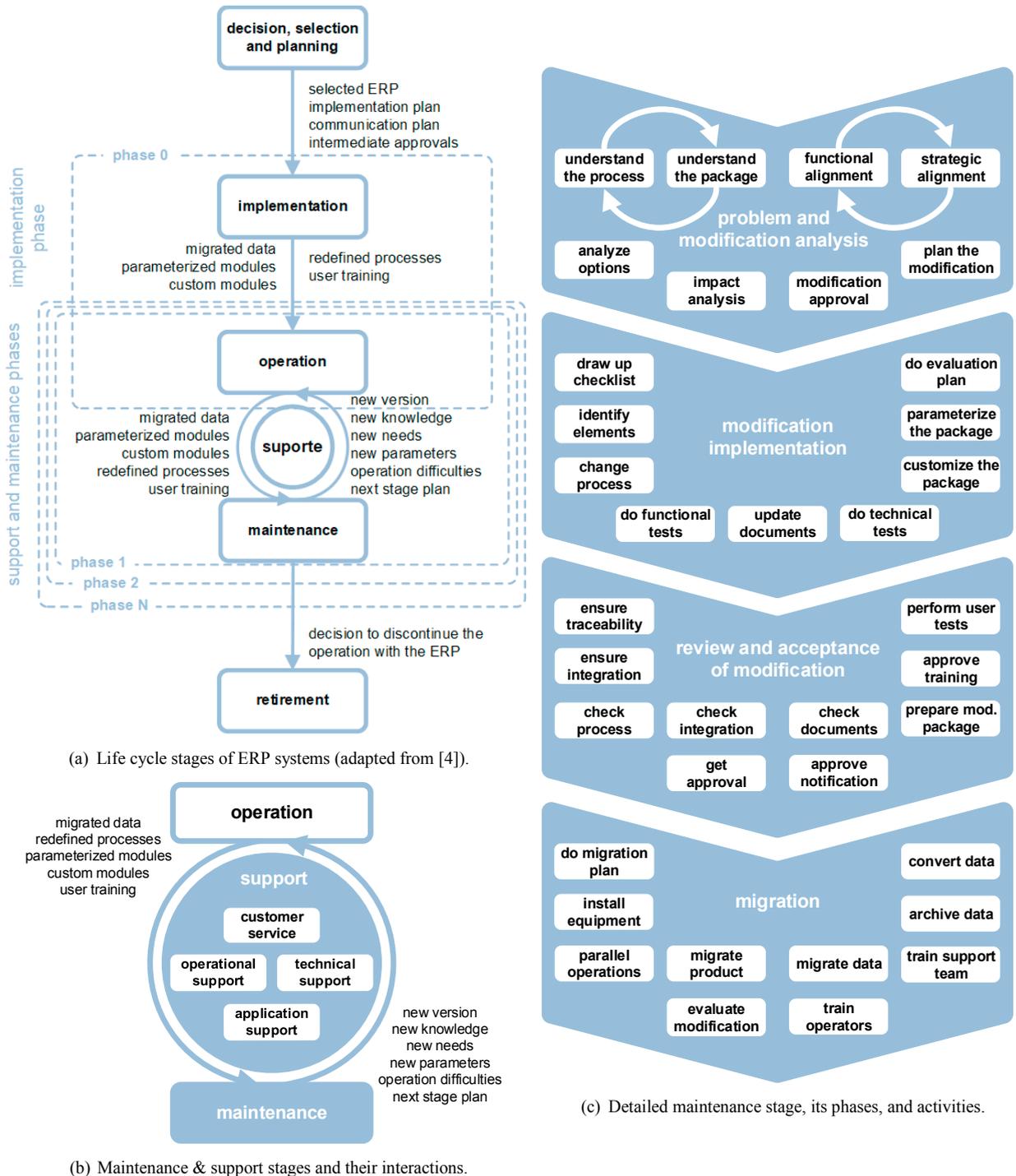


Fig. 1. Life cycle stages of ERP systems, M&S stages and their interactions and Detailed maintenance stage, its phases, and activities.

This stage should also promote tests with the customer or end user and training approval. This phase should include verifying that business process has been properly supported, that various ERP components are correctly integrated and

that documents are properly modified. The modified package to be used in the migration phase should also be prepared. This phase should be completed with the modification approval and the respective notifications to all interested parties.

The last phase of the proposed model here is migration. The migration involves installing the new version of the system in an environment different from the one used in the implementation of the modification. Consistent with ISO 12207 and 14764 [14], [15], this phase includes the elaboration of a migration plan comprising main activities to be carried out during this phase, such as the eventual installation of equipment, data conversion or archiving data. Then, the product and data must be migrated to operational environment. It may also be useful to conduct parallel operations in the old environment and in the environment with the new system version, to ensure a smoother transition to the new environment. Finally, this phase ends with the training of support team and operators and with an overall assessment of the modification made. The detailed maintenance stage in ERP systems and its activities is illustrated in Fig. 1 (c).

Although support is closely related to maintenance, the perspective of the proposal presented here is based on the autonomy of both stages. The support lies between operation and maintenance. This is one of the significant differences of this model of maintenance in ERP systems in relation to the approaches of ISO 12207 and 14764 [14], [15]. Unlike the ISO 14764 standard, here we propose support not only outside the migration phase, more than that, outside maintenance itself. The relationship between maintenance and support is illustrated in Fig. 1 (b).

The proposed support stage is based on ITIL (Information Technology Infrastructure Library) framework. According to ITIL, a service means adding value to customers, facilitating the results that customers want to obtain without specific costs and risks. An IT service is a service provided by an IT service provider and is made up of a combination of information technology, people and processes [28]. IT service can be provided according to four functions: customer service, IT operational support, technical support, and application support.

Customer service acts as the single point of contact and communication with ERP users and a point of coordination for various groups and processes. Service process income incidents, service requests, or change requests. Usually it owns and runs the incident management process [28], [29]. Operational support includes the daily operational activities required to manage IT services and system support infrastructure. It includes operations control that refers to regular maintenance cycles associated with infrastructure management, including activities such as console management, backup and restore operations, media management, or performing batch work. It also includes facility management, which is concerned with maintaining the facilities that support ERP operations, such as data centers, call centers or development facilities, and responsibilities like HVAC, fire safety, access to facilities or energy [28], [29]. Technical support provides detailed technical skills and resources needed to support ongoing operation of IT services and support of the ERP system infrastructure. Technical support is usually divided into specialized areas, representing different teams or specialized functions within an IT organization, for example networks, security, database, storage, servers, etc. The main purpose of technical support is to ensure that the service provider has the appropriate skill sets available to provide the services it offers [28], [29]. Application support is responsible for the management of the ERP system and its modules throughout its life cycle. It is concerned with the end-to-end management of ERP system components. Application support performs processes such as incident, problem, change or availability management [28], [29].

5. Action Research in an implementer company

Although, M&S services in an ERP implementation can be internally provided, they are usually outsourced. This was the context of this investigation, carried out in a small and medium-sized Portuguese company that provides services and technologies, in which one of its main activities is the implementation, maintenance and support of ERP systems in other organizations. It started its activity in 1992 by developing solutions for various sectors of production control and marketing of computer equipment. In 1996, due to the success of developed solutions, they broadened their horizons and created an ERP system development department, which has been gaining a strong position in this market. Over more than 20 years of activity, the company has experienced constant annual growth, and is currently well positioned in various business sectors, such as communication, furniture, foundry, transformation, textile, ceramic industry, and public sector. This study focused on the M&S practices adopted by this company with its customers.

The used methodology was the action research, which consists of collecting systematic information with the aim of promoting social changes. Action-research implies the researcher's involvement in joint learning. One of the authors of this article was directly involved in practical activities in the company under investigation, assuming a double commitment to study the way the organization works and to propose changes to it. Initially, opinions were collected

from employees in the customer support department. This collection was made through a questionnaire with nine open-ended questions and answered in the most comprehensive way possible by the respondents. After obtaining the answers, it was possible to get a better knowledge about maintenance and support practices at the company.

An instrument was developed, covering all 45 activities provided in the proposed model. This instrument allows an evaluation of an implementing company as to its level of maturity in each of these activities. This tool offers a way to evaluate where an organization is, and where it needs to go, to attain and improve maintenance and support activities. Second, if evaluation is made at different moments of the company life, it may be used to help to see eventual progress in the correspondent period. Finally, it may underline weaknesses or strengths and so, it helps to define a strategy with underlying objectives that allow the company to evolve and gain a better strategic position in the market. The method used to measure all maturity levels was the Likert scale. The scale ranged from 1 (“no/poor process”) to 5 (“optimized process”). This assessment was made after reflection by the researcher who was involved in organizational practices.

The company's maintenance starts when all ERP modules are installed on the client, usually, without a first analysis of the real client needs. Only if customer says that he does not need a module, then it is removed. At installation, there is no training or strategy to reduce possible users' resistance. When collecting and migrating data, data that customer intends to migrate to new system is considered, with an agreement between company and customer. If users have a problem with the ERP, they send an email to support, which is then assigned to one of the department's employees. They are the ones who analyse the urgency and priority of each request, prioritizing errors, legal problems, accounting situations and situations that jeopardize the good functioning of the client company. If nobody from customer support department is available to solve the issue, the problem is passed to the development department. There are also no tests performed on the corrections made and the lack of a test team was highlighted. Until last version of the ERP package, there were no user support manuals, something that the company has been improving a lot in last year.

The maturity assessment made by the researcher of 45 evaluated activities revealed that 20% of them (9) are not yet implemented or are very poor, 31% (14) represent processes very much in the its beginning, 38% (17) already implemented, 11% (5) improved processes and there are still no activities considered as optimized processes. The analysis of existing M&S practices in this SME allowed us to understand that it has significant weaknesses and, therefore, also presents great opportunities for improvement. The evaluation carried out to all activities shows opportunities for improvement, although some more than others. As there is no space to address all of them, some activities stand out among those that present the greatest opportunities for improvement, that is, those classified with the degree of maturity 1. We highlight those associated with the change of processes, parameterization of package, preparation of user tests, guarantee of traceability of requirements and obtaining approval of modification.

New processes design is also not being explored by this implementer. This could allow more value and additional revenue for the customer. Another activity with great opportunity for improvement is package parameterization. It is always one of the easiest and fastest ways to adjust an ERP system to customer business, without the need to customize the package, a process that is always more expensive and longer. The lack of a testing strategy, including quality tests, regression, performance, integration and, acceptance tests by users is also considered a weakness in this company. This implementer should assure that the new version meets requirements and is aligned with business, ensuring traceability of requirements from beginning of maintenance until its completion. Formal maintenance approval is also missing, ensuring that level of service contracted between service provider and customer has been met.

6. Conclusion

Organizations continue to try to gain competitive advantages over their competition through the adoption of ERP systems. Until recently, companies were essentially focused on the ERP implementation phase and the stages that precede it. However, after several installations failed, it was concluded that one of the main problems was related to the lack of customer support and adequate maintenance of the system, by suppliers. This paper presents a proposal of a M&S model within the ERP systems lifecycle. The model includes 41 maintenance activities separated by 4 phases, respectively, the analysis of the problem and the modification, the implementation of the modification, the revision and acceptance phase and after all, the migration. The model also includes 4 activities of support. Contrary to other proposals in the literature, this model put support autonomously from maintenance. This positioning has the advantage to evidence the role of support between operation and maintenance. Finally, this paper presents an action research that was performed in an ERP implementer company. This research included an evaluation of the level of maturity of all

45 maintenance and support activities proposed in proposed model of an implementing company. The analysis of the existing M&S practices in the SME allowed us to understand that this implementer company has significant weaknesses and therefore, also presents great opportunities for improvement. Some of these practices were discussed.

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