

Criteria selection for evaluation of ERP systems implementation in large Brazilian companies

160

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Reinaldo José De Freitas

*Master in Management Systems, Federal University of Fluminense,
Rio de Janeiro, Brazil*

Helder Gomes Costa and Valdecy Pereira

*Department of Production Engineering, Federal University of Fluminense,
Rio de Janeiro, Brazil, and*

Eduardo Shimoda

*Department of Production Engineering, University of Candido Mendes,
Rio de Janeiro, Brazil*

Abstract

Purpose – This paper aims to identify criteria that can be used in assessing the successful implementation of ERP (enterprise resource planning) in large companies.

Design/methodology/approach – Based on a systematic review conducted in 74 selected articles from a survey performed in Scopus bases and Institute for Scientific Information (ISI) Web of Science, an initial set of 34 criteria was defined and used for evaluating the implementation of ERP systems. This set was submitted to a sample of 111 experts in ERP for evaluation via electronic forms provided through the EncuestaFácil site. The collected data were treated by applying the Content Validity Ratio (CVR) method. The criteria selection is based on the integration of two methodological approaches: systematic review and the application of CVR method for validation of ratings issued by experts.

Findings – As a result of the research, 25 criteria were identified and validated to evaluate the implementation of ERP systems, focusing on large Brazilian companies.

Practical implications – The research results can be very useful to managers using ERP systems and have significant utility for organizations that develop ERP systems.

Originality/value – According to studied literature, no previous study has used this integration in the identification of criteria for assessing the implementation of ERP systems in large Brazilian companies. On the other hand, the use of these two approaches assured confidence in the validity of the findings.

Keywords Evaluation, Brazil, Enterprise resource planning, ERP, Criteria, CVR, Large companies

Paper type Research paper

Resumen

Objetivo – Este estudio tiene como objetivo identificar los criterios que se pueden utilizar en la evaluación de la implementación exitosa de ERP (*Enterprise Resource Planning*) en grandes empresas brasileñas.

Proyecto/ Metodología/ Enfoque – A partir de una revisión sistemática, realizada en 74 artículos seleccionados de una encuesta realizada en las bases Scopus y el ISI Web of Science, se estableció un

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conjunto inicial de 34 criterios utilizados en la evaluación de la implementación exitosa de los sistemas ERP. Este conjunto fue sometido a una muestra de 111 expertos en sistemas ERP. Las evaluaciones fueron recogidos a través de formularios electrónicos a través del sitio EncuestaFácil, y la confidencialidad de las respuestas garantizadas por el servicio contratado con este sitio. Los datos recogidos fueron tratados por el uso del método de CVR (Content Validity Ratio).

Resultado – Como resultado de la investigación, se identificaron y validado 25 criterios para evaluar la implementación de sistemas ERP, centrándose en las grandes empresas brasileñas.

Originalidad/Valor – Los resultados de la búsqueda pueden ser muy útiles para los administradores que utilizan los sistemas ERP y tienen utilidad significativa para las organizaciones que desarrollan sistemas ERP. El criterio de selección se basa en la integración de los dos enfoques metodológicos: revisión sistemática y la aplicación del método CVR para la validación de las calificaciones emitidas por los expertos. No hay en estudios anteriores informes de la literatura que utilizan esta integración en la identificación de los criterios para evaluar la aplicación de los sistemas ERP en grandes empresas brasileñas. Por otro lado, el uso de estos dos enfoques aseguró confianza en la validez de los resultados.

Keywords ERP, Evaluación, Criterios, Éxito, CVR

Clasificación del artículo trabajo de investigación

Resumo

Objetivo – Este estudo tem como objetivo identificar critérios que possam ser utilizados na avaliação do sucesso da implementação de sistemas ERP (*Enterprise Resource Planning*) em empresas brasileiras de grande porte.

Projeto/Metodologia/Abordagem – A partir de revisão bibliográfica sistematizada, efetuada em 74 artigos selecionados de pesquisa efetuada nas bases Scopus e ISI Web of Science, foi definido um conjunto inicial composto por 34 critérios utilizados na avaliação de sucesso na implementação de sistemas ERP. Este conjunto foi submetido a uma amostra composta por 111 especialistas. As avaliações foram coletadas através de formulários eletrônicos disponibilizados através do site EncuestaFácil, sendo a confidencialidade das respostas garantida pelo serviço contratado junto a este site. Os dados coletados foram tratados pelo emprego do método CVR (Content Validity Ratio).

Resultado – Como resultado da pesquisa, foram identificados e validados 25 critérios para avaliação da implementação de sistemas ERP, com foco em empresas brasileiras de grande porte.

Originalidade/Valor – Os resultados da pesquisa podem ser muito úteis aos gestores que utilizem sistemas ERP e têm significativa utilidade para as organizações que desenvolvem sistemas ERP. A seleção dos critérios é fundamentada na integração de duas abordagens metodológicas: revisão bibliográfica sistematizada e a aplicação do método CVR para a validação das avaliações emitidas pelos especialistas. Não foi encontrada na literatura relato de trabalho prévio que utilize-se de tal integração na identificação de critérios para a avaliação da implementação de sistemas ERP em empresas brasileiras de grande porte. Por outro lado, o emprego destas duas abordagens, assegura confiança na validade dos resultados encontrados.

Keywords ERP, Avaliação, Critérios, Sucesso, CVR

Classificação do artigo trabalho de pesquisa

1. Introduction

Despite growth in the adoption of enterprise resource planning (ERP) systems by companies in the past two decades, the evaluation of the successful implementation of ERP systems by organizations is an area that is under-researched (Wu and Wang, 2006). There are no scientific and clear assessment criteria on how to assess the effectiveness of the implementation of an ERP project accurately and comprehensively (Qin and Wei, 2013). Most of the existing literature in this context is related to the selection of ERP software and critical success factors (CSFs), which is not concerned with the

measurement of performance after a system's implementation (Esteves and Pastor, 2001). Because of this, some researchers have begun to study what possible criteria could be used to evaluate the final outcomes of an ERP system implementation.

According to Wei (2008), the main reasons why a company should analyze the performance of their ERP systems are:

- ERP systems are more complex than any traditional information system (IS). The installation of an ERP system requires high investments of money, time and energy.
- All of an organization's business processes are involved with ERP systems. The ERP system used will influence all business operations and strategies in the future.
- ERP systems are created on the basis of procedural and generic business rules. Implementing an ERP system requires customization and the adaptation of work processes based on the company's business practices. Many of today's business processes can suffer reengineering and change.

An ERP system cannot just meet the requirements of current business functions, it must also meet future requirements. Because of this, continuous maintenance and updating are very important.

A lack of knowledge on the part of large Brazilian companies about the criteria that should be used to evaluate the success of their ERP system implementations is the primary motivation for this work.

Thus, this study aims to answer the question: what factors are perceived to be important for determining whether the implementation of an ERP system has been successful by professionals working in large Brazilian companies?

2. Conceptual reference

An ERP system can be defined as a software package that provides transaction processing in an integrated way and which gives access to information that crosses multiple organizational units and business functions. These functions include finance and accounting, human resources, supply chain and customer services management (Van Everdingen *et al.*, 2000).

Most companies expect that an ERP implementation should reduce their operating costs, increase process efficiency, improve customer responsiveness and provide information that enables seamless decision-making. In addition, it should enable the standardization of embedded processes and facilitate the discovery of those best practices that ensure quality and predictability for a global business by reducing the time taken between receiving an order and effecting its delivery (Ross, 1999).

Based on Goh's (2006) analysis, ERP systems are at the core of a company's business functions and, therefore, understanding them is essential. They can also serve three main objectives within the organization, i.e. operational, tactical and strategic goals.

Success is often defined as a favorable or satisfactory outcome (Saarinen, 1996). The effectiveness of success measurement systems in the implementation of IS has been researched widely for decades and is considered a difficult but necessary task (Radecki, 1976). The existing literature on the subject can be classified as addressing one of the following three concerns:

- (1) The contribution made by IS to efficiency from the perspective of organizational workflows (i.e. data processing time savings and labor reduction) (Gibson *et al.*, 1999);
- (2) The impact of IS on the satisfaction of an organization's end-users (i.e. ease of use and system reliability) (Rockart and Flannery, 1983); and
- (3) The financial contribution made to an organization by IS implementation (i.e. cost/benefit analysis and return on investment) (Faleti, 2001).

Performance measurement and evaluation are critical for ensuring the successful implementation of any IS. With regard to ERP, performance evaluation can be considered particularly important because of the depth to which effects made by any implementation can be felt by an organization (Hakkinen and Hilmola, 2008a, 2008b). In addition, ERP implementation projects are much more complex than typical IS projects in terms of their organizational scope, budget and design time (Yu, 2005).

The implementation of an ERP system cannot be seen as an end in itself because achieving any ultimate business goal involves continuous work and improvement over time. In this context, the evaluation can become oversimplified if it is tried to be understood by means of a single approach (Yu, 2005). Instead, several tools and perspectives must be used (Soliman *et al.*, 2001).

Most of the extensive literature on ERP applications tends to focus on adoption-related issues, CSFs and implementation methodologies (Esteves and Pastor, 2001). However, the analysis of the success of ERP packages in organizations' post-implementation is an area that is under-researched (Sedera and Gable, 2004; Wu and Wang, 2006).

Some researchers have used the dimension of user satisfaction as a basis for the evaluation of the success of IS implementation. Bailey and Pearson (1983) were the first to develop a valid and useful measure for user satisfaction. This model was exploited in other studies, such as the model developed by Ives *et al.* (1983) and Raymond (1987).

The excess of IS success analysis approaches led DeLone and McLean (1992, 2003) to develop an integrated, multidimensional and interrelated IS success measurement model that has become the most dominant model to analyze successful IS (Petter *et al.*, 2008). The model contained the following dimensions: system quality, information quality, use, user satisfaction, individual impact and organizational impact. Later, DeLone and McLean (2003) redefined their original model by incorporating the service quality dimension. This dimension had already been tested by several other investigators (Jiang *et al.*, 2000) and so was considered applicable for the successful evaluation of IS.

Based on the work of DeLone and McLean (1992), Sedera and Gable (2004) developed a supplementary model that redefined DeLone and McLean's original IS success evaluation. Focusing on ERP systems, they aimed at reducing the number of evaluation criteria deployed. Thus, the new model eliminated the dimensions of use and user satisfaction from the original DeLone and McLean criteria, as the use of these dimensions in IS success evaluation has been criticized strongly by several researchers (Gable *et al.*, 2008; Saarinen, 1996).

The most critical dimension of Sedera and Gable's model is the organizational impact dimension because it is broadly held that the implementation of an ERP system is considered a success when it brings cost reduction benefits, increased productivity and

increased levels of customer satisfaction to an organization (Saarinen, 1996; Sedera and Gable, 2004). Although they failed to consider the service quality dimension, this aspect is regarded crucial by other researchers (Ifinedo *et al.*, 2010).

Sedera and Gable's (2004) model influenced other researchers (Ifinedo and Nahar, 2007), who used it as a basis for their own constructions, which had an added dimension described as "workgroup impact". Working groups correspond to subunits and/or functional departments in an organization. Some other dimensions of analysis have been treated in subsequent studies (Kanellou and Spathis, 2013; Nizamani *et al.*, 2014) but these have not had much adherence among other researchers or are been longer considered in the cited dimensions.

The meaning of each dimension considered in this study can be seen in Table I.

This study seeks to present an alternative assessment model to those already found in the existing literature by using evaluation criteria that adhere to the reality experienced by large Brazilian companies.

3. Methodology

To achieve the objective of this study, the following steps were taken: literature review, the identification of the main evaluation methods, the identification of the main evaluation criteria, the construction of a survey questionnaire, data collection and the presentation and analysis of results.

The literature review allowed the identification of the most used methods and criteria for evaluating success in implementing ERP systems. Based on this research, a questionnaire was built, which was supplied to a group of experts to obtain their views regarding the applicability of these criteria in evaluating the successful implementation of ERP systems in large Brazilian companies.

The following details the development of the steps undertaken.

Dimension	Description
System quality	Features of ERP system performance with respect to ease of use, accuracy, reliability, efficiency, etc.
Information quality	Features of the outputs provided by the ERP system with respect to timeliness, relevance, availability, ease of understanding, etc.
Service quality	Support the organization receives from the person responsible for system maintenance, which is usually represented by reliability, loyalty, quality experts, etc.
Individual impact	Refers to the ERP system's effects on individuals, often analyzed through increased individual productivity, improved ability to make decisions, etc.
Workgroup impact	The impact of the ERP system on subunits or departments within the organization, often analyzed by identifying improving interdepartmental coordination, communication and productivity
Organizational impact	The benefits that the organization gets from the ERP system, often measured by the level of service to the customer, improving decision-making processes, etc.

Table I.
Definitions of success dimensions

3.1 Literature review

The literature review was conducted between May and July 2012, and it was structured based on the work of [Costa \(2010\)](#), [Méxas et al. \(2012\)](#), [Neves et al. \(2013\)](#), as described below:

- *Step 1:* Selecting the scientific basis for the search. At this stage, the choice of places that would be used in the literature review was made. Because of the scope of the work available and their recognition by academia ([Costa, 2010](#); [Neves et al., 2013](#)), Scopus and ISI (Web of Knowledge), accessed through the CAPES (Coordenação de Aperfeiçoamento de Pessoal de Nível Superior) periodicals portal, were used as primary sources. (SciELO) was also used to access the full text of some articles that were not available via Scopus and ISI.
- *Step 2:* Selecting keywords and search phrases. In this step, the keywords to be used in research were defined and these were combined in the following search phrase: (ERP OR “Enterprise Resource Planning”) AND (evaluation OR assessment) AND (success OR effectiveness OR satisfaction OR Performance) AND (model OR framework OR measurement) AND (implementation).
- *Step 3:* Research on the bases. In this phase, research was done in selected bases using the defined search phrase to retrieve as many articles related to the topic for research as possible. The search returned 38 articles in Scopus and 47 articles in ISI (Web of Knowledge). Of this total, 11 existed in both bases, thus 74 different articles were identified.
- *Step 4:* Analysis of the abstract of all articles identified in the research. The abstracts of the articles obtained from the survey were analyzed to identify those that might be applicable to the theme of the research. Of the 74 articles obtained, 29 articles that were most related to the research theme were selected for further analysis.
- *Step 5:* Detailed reading of the articles related to the research theme. A detailed reading of the articles identified in the previous step was undertaken for the identification of the criteria that were related to the evaluation of ERP systems implementation. This analysis included 14 articles that, in fact, contributed to the identification of the methods usually used in the evaluation of the implementation of ERP systems and also to define the initial set of criteria to be evaluated. The obtained articles can be seen in [Table II](#) below.

3.2 Identification of the main evaluation methods

Based on selected articles in the literature review, the main methods used in the successful evaluation of the implementation of IS were identified. The characteristics of each can be seen in [Table III](#).

Although IS performance has been studied for a long time, there is little literature to report how to develop appropriate performance indicators to evaluate the performance of an ERP system ([Wei, 2008](#)). For example, even [Hunton et al. \(2003\)](#) found no improvement in the financial performance of companies that have adopted ERP systems but noted that the financial performance of those that did not engage decreased over time, while that of companies that adopted an ERP system remained stable. [Tallon et al. \(2000\)](#) cited a number of studies indicating that economic and financial measures cannot

Table II.
List of selected
articles

Article title	Authors	Publication year
Measuring the performance of ERP software: a balanced scorecard approach	Rosemann, M.; Wiese, J.	1999
A comprehensive framework for classifying the benefits of ERP systems	Shang, S.; Seddon, P.B.	2000
Intangible benefits valuation in ERP projects	Murphy, K.E.; Simon, S.J.	2002
An examination of ERP user satisfaction in Taiwan	Wu, J.H.; Wang, Y.M.; Chang-Chien, M.C.; Tai, W.C.	2002
Confirmatory factor analysis of the end-user computing satisfaction instrument: replication within an ERP domain	Somers, T.M.; Nelson, K.; Karimi, J.	2003
Identifying high performance ERP projects	Stensrud, E.; Myrtevit, I.	2003
Measuring ERP success: the ultimate user's view	Wu, J.H.; Wang, Y.M.	2006
A study on performance of introducing ERP to semiconductor related industries in Taiwan	Lin, W.T.; Chen, S.C.; Lin, M.Y.; Wu, H.H.	2006
Evaluating the performance of an ERP system based on the knowledge of ERP implementation objectives	Wei, C.C.	2008
Life after ERP implementation: long-term development of user perceptions of system success in an after-sales environment	Hakkinen, L.; Hilmola, O.P.	2008
An ERP performance measurement framework using a fuzzy integral approach	Wei, C.C.; Liou, T.S.; Lee, K.L.	2008
On performance evaluation of ERP systems with fuzzy mathematics	Chen, S.G.; Lin, Y.K.	2009
Relationships among ERP post-implementation success constructs: an analysis at the organizational level	Ifinedo, P.; Rapp, B.; Ifinedo, A.; Sundberg, K.	2010
An ERP system performance assessment model development based on the balanced scorecard approach	Chang, S.; Yu, S.; NG, C.S.; Chang, I.; Yen, D.C.	2011

Table III.
Performance
evaluation methods

Method	Features
Financial analysis	Based on an analysis of financial performance measures, such as return on assets, return on investment and cost-benefit analysis
User satisfaction (survey)	Based on the analysis of the experience and perceptions of system users
Multivariate analysis	Based on the analysis of two or more dimensions, such as: system quality, information quality, use, user satisfaction, individual impact and organizational impact
Data envelopment analysis-DEA	Based on the analysis of the efficiency of organizational units through their respective inputs
Quality function deployment-QFD	Based on the split of the quality of a product in the functions that contribute to the quality of the company

accurately assess the return for IT projects and suggested that one way to determine their value is through the perception of executives.

Some researchers consider the evaluation of success in the adoption of ERP systems taken from the single point of view of user satisfaction as simplistic, incomplete, limited and possibly misleading (DeLone and McLean, 1992; Saarinen, 1996; Sedera and Gable, 2004).

The (DEA) and (QFD) methods still have few supporters in the literature that is focused on the evaluation of the success of ERP systems.

Thus, the performance evaluation of an ERP system should incorporate a number of objectives and criteria, including system functionality and the dimensions of organizational impact (Wei, 2008).

3.3 Identification of the main evaluation criteria

DeLone and McLean (1992) noted that many researchers avoided the use of objective measures of performance because of the difficulty of isolating the effects of IS that are influenced by the performance of organizations. The fact is that objective measures are difficult to get from organizations and to quantify (Mabert *et al.*, 2003). However, perceptual measures are easier to get from organizations, and these can also lend themselves to the development of performance evaluation tools (Gable *et al.*, 2008; Ifinedo and Nahar, 2007).

Thus, based on selected articles in the literature review, the main criteria used in the successful evaluation of the implementation of ERP systems were identified. Inspired by the work of Méxas *et al.* (2012), the criteria were grouped by dimension and standardized to avoid duplication and ambiguity.

3.4 Construction of the survey questionnaire

Based on the criteria raised, a survey questionnaire was built, which is presented in Appendix 1 below, with a view to supplying the same to a panel of experts participating in the implementation of ERP systems in large Brazilian companies. The questionnaire was divided into three parts, as is described below:

- (1) *Introduction*: This part presented the objectives of the form, in addition to the assumptions and constraints that should be followed during its completion.
- (2) *Respondent profile*: This section elicited information about the person who was answering the questionnaire. The following information was sought: gender, age, education level, current function, ERP systems used and sectors in which the respondent had already participated in ERP implementations.
- (3) *Evaluation criteria*: This part questioned the perceptions of respondents with regard to the success evaluation criteria for the implementation of ERP systems obtained from the previous literature review. For each criterion, the respondent could choose from the following alternatives:
 - 0: It is not important;
 - 1: Important, but not essential;
 - 2: Essential. To be used as a success evaluation criterion; and
 - NS/NC: I do not want to answer/I have no opinion/I cannot answer.

The options used in the evaluation criteria were based on the questionnaires content evaluation method developed by Lawshe (1975).

3.5 Data collection

To get a panel of experts who could assess the raised criteria, experts with experience in the implementation of ERP systems were selected. The details of these experts were obtained from lists of staff who were implementing ERP systems projects. To participate in the survey, experts had to:

- be at least 21 years old;
- have an undergraduate degree; and
- have been working on the implementation of ERP systems in large companies for at least three years.

In addition, they were required to be from the following categories of employees:

- *Key user*: responsible for defining how ERP systems are configured;
- *Consultant*: responsible for ERP system configurations;
- *Project Manager*: responsible for managing ERP projects; and
- *Executive*: professionals in executive positions at companies, e.g. presidents, directors, managers, etc.

Telephone and email contacts were made with these experts aiming to clarify the research objectives and to identify other experts who could contribute to the research. Thus, 265 specialists in the implementation of ERP systems who fulfilled the study's defined criteria were identified.

Before forwarding it to the raised panel, the questionnaire was sent to 11 experts to conduct a pretest. After receiving their comments, one improvement in the ambiguous text of a criterion was made.

The survey was sent by email via the Encuestafácil Web site (www.encuestafacil.com) to the 265 experts previously identified. The email stipulated that the form should be completed based on the interviewee's experience of ERP systems implementation in large companies and that the restrictions contained in this form should be borne in mind during its completion. The form emphasized that the study was concerned with experiences at large companies and stated the respondent profile that was applicable for a valid study.

The confidentiality of responses was guaranteed by a service agreement with the Web site by which it was distributed. Thus, the form had a confidentiality guarantee label for all survey respondents.

The survey was conducted from March 18th, 2013 to April 25th, 2013. During this period, 111 completed forms were obtained, which corresponds to 41.88 per cent of the total number of questionnaires issued.

3.6 Presentation and analysis of results

These sections show the search results based on the completed questionnaires. We selected only the questionnaires that had been completed.

After collection, all data were entered into a Microsoft Office Excel 2007 spreadsheet to facilitate the processing and analysis of data.

3.6.1 Profile of respondents. As can be seen in Figure 1 below, the question regarding the gender of the students showed that of the 111 respondents, 77 per cent were male and 23 per cent were female. This was a realistic gender split, as the field studied is still dominated by men.

Figure 2 shows that the great majority of respondents were between 30 and 39 or between 40 and 50 years of age. Added together, these age groups accounted for 80 per cent of the respondents. This was quite a reasonable result, as we were dealing with ERP systems experts, who one could assume had already worked in that field for some time.

As can be seen in Figure 3, most respondents had *lato sensu* graduate degrees (51 per cent). The high standard of the respondents' educational levels might be assumed to have reduced the potential for any lack of understanding of the issues questioned.

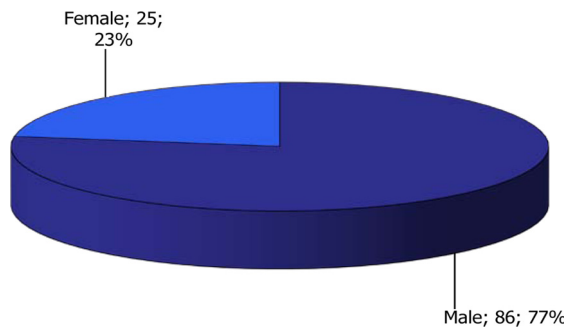


Figure 1. Percentage of respondents by gender

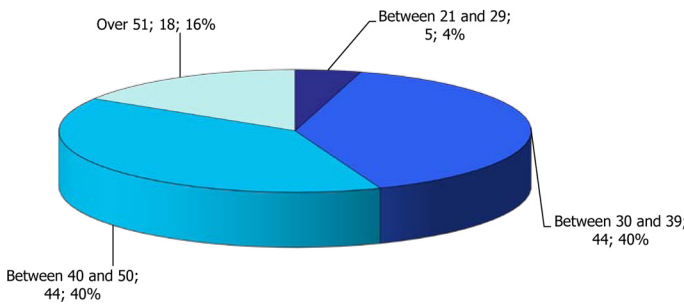


Figure 2. Percentage of respondents by age

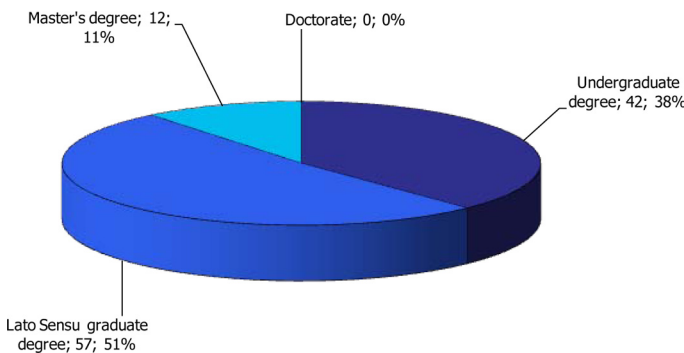


Figure 3. Percentage of respondents by education level

As seen in Figure 4, the question for the current function of each of the students showed that most respondents (51 per cent) were acting as ERP systems consultants. As it is normal in this marketplace for key users to become consultants, we could assume that most of these consultants may have had prior experience as key users.

Figure 5 shows that the Systems Applications Products (SAP) ERP system appeared as the system where the majority of respondents (98 per cent) had had implementations experience. This also makes a lot of sense, as the SAP system has the largest market share among large enterprises (Bottazzini and Calado, 2011), which is the sector focused upon by this research.

Figure 6 shows that the majority of respondents (49 per cent) had over 12 years' experience of implementing ERP systems, which is quite consistent with the results obtained from the question above concerning the ages of respondents.

Figure 7 demonstrates that there was a good distribution across the kinds of sectors in which the respondents had worked on ERP systems implementations. It shows that the experts contacted had experience in more than one sector, and energy (71 per cent), telecommunications (51 per cent) and industrial production (40 per cent) could be highlighted as the sectors in which the survey respondents had most experience.

3.6.2 Selection of criteria. A method defined by Lawshe (1975) was used to validate the criteria of this research. This method is used for questionnaires validation in several

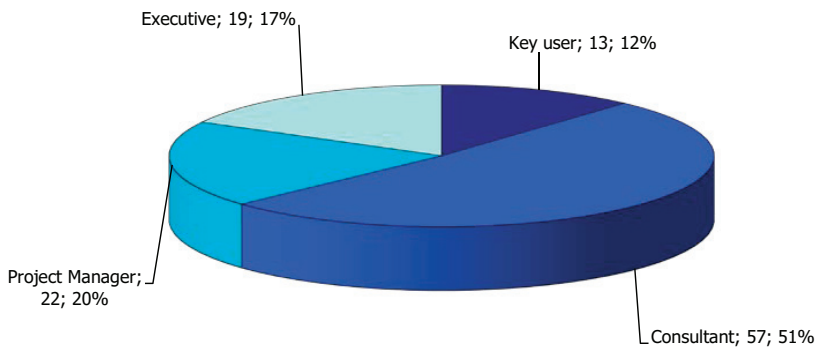


Figure 4. Percentage of respondents by the current function

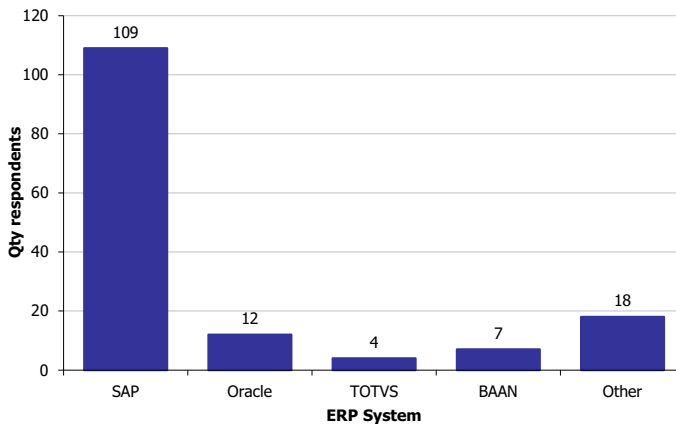


Figure 5. Experience of respondents in ERP systems

studies in the reviewed literature (Wei, 2008; Chang *et al.*, 2011). In this method, a content validity ratio (CVR) is calculated for each item of a questionnaire. In this research, the items to be evaluated were the criteria identified in the literature review.

Thus, based on Lawshe (1975), to validate the questionnaire criteria, each criterion had to be submitted for evaluation by subject matter specialists, where each expert should assess the criteria as “not important”, “important, but not essential” or “essential”, with regard to the need to maintain the criterion in the questionnaire. To do so, the method defines that the CVR for each criterion should first be computed according to the following formula:

$$CVR = \frac{\left(n - \frac{N}{2}\right)}{\frac{N}{2}}$$

where *n* indicates the number of experts who considered the criterion as “essential”. The symbol *N* considers the total number of experts who evaluated the criterion. Depending on the number of experts who evaluate each criterion, Lawshe (1975) defines a CVR minimum value for the criterion to be maintained in the questionnaire. Because of the deficiencies existing in the table of CVR minimum values defined by Lawshe (1975), the

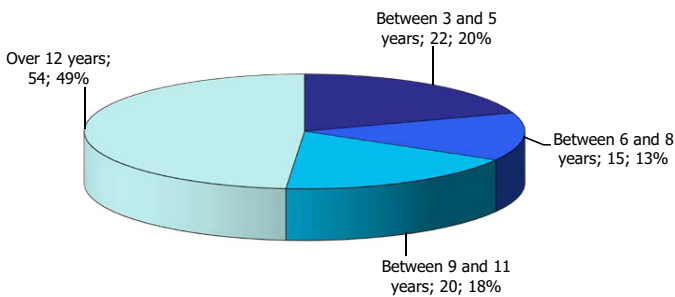


Figure 6. Percentage of respondents by time experience in ERP systems implementation

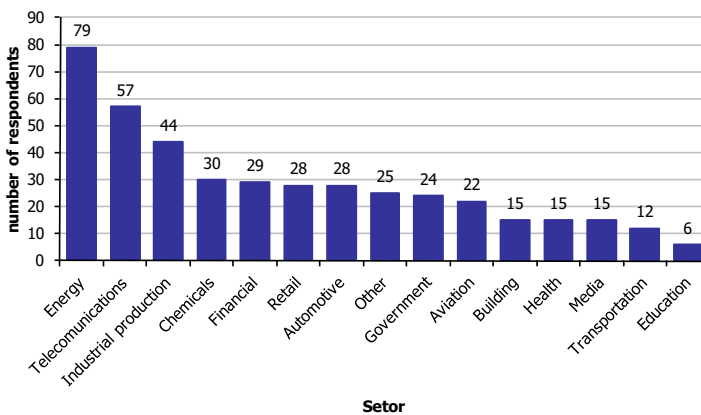


Figure 7. Experience of respondents by sector of activity in ERP systems implementation

CVR minimum value for each criterion was used according to the study by *Wilson et al. (2012)*. The complete table of CVR minimum values can be seen in [Appendix 2](#) below.

According to the responses from the questionnaires, CVR values (calculated and minimum) for each criterion have been presented for verification in [Table IV](#).

Thus, 25 (73.5 per cent) of the 34 criteria were considered valid in the successful evaluation of the implementation of ERP systems in large national companies, according to the sample of 111 respondents who completed the survey. In addition, it should be noted that the criterion “System reliability” was the criterion with the highest rating with 104 (95.4 per cent) of 109 experts calling it “essential”. On the other hand, the criterion “Ease of system use” had the worst rating with only 35 (31.8 per cent) of 110 experts rating it “essential”.

4. Conclusions

After an extensive literature search, it was noticeable how little explored was the evaluation of successful ERP systems implementation, both in Brazil and abroad. Despite the confusion between the terms “implementation” and “deployment”, it should be noted that the term “implementation” was used because it is more comprehensive, i.e. it places its emphasis on the result of the work as a whole, while the term “deployment” is more related to the migration period from one system to another.

It could be observed that most of the related research has been focused on the analysis criteria for selecting a software vendor, identifying CSFs or implementation methodologies. So, perhaps due to the lack of studies in the area, it is very difficult to find a company in Brazil that has made an assessment of the success of its implementation. Therefore, it could be said that thousands of investments might have been made without the investors ever knowing whether the expected benefits have been achieved. This work was developed exactly to help fill this gap by identifying criteria that may be assessed by large Brazilian companies that are implementing ERP systems.

The existing literature highlights three main assessment methods for evaluating the success of ERP systems, which were grouped at work as: methods based on financial analysis, methods based on user satisfaction and methods based on multidimensional analysis. As there is a consensus that the first two groups of mentioned methods are limited in their evaluation of successful implementation of ERP systems, due largely to the complexity of this type of system, the identification of the criteria in this study took into account criteria of various dimensions. The main dimensions found in the literature were: system quality, information quality, service quality, individual impact, workgroup impact and organizational impact.

Regarding the criteria used to evaluate the success of ERP systems, after an evaluation of several existing articles in the literature, 34 different criteria were identified. After the construction of the questionnaire in a research Web site that ensured the confidentiality of responses, the criteria for distribution were examined to identify the 265 Brazilian experts in the implementation of ERP systems to whom the questionnaire was then addressed.

At the end of the study, 111 experts had completed the questionnaire. In a profile analysis of these experts who completed the questionnaire, it was found that: 77 per cent were male, 80 per cent were between 30 and 50 years of age, 51 per cent had *lato sensu* graduate degrees, 51 per cent were working as consultants, 98 per cent had worked with SAP systems, 49 per cent had over 12 years’ experience with ERP systems and 71 per

Dimension	Criterion	Total responses	Responses to "essential"	CVR calculated	CVR minimum	Status
Information quality	Understanding user information	110	100	0.818	0.187	Maintain
	Documentation	111	63	0.135	0.186	Remove
	Usefulness of information	110	91	0.655	0.187	Maintain
	Meeting the needs of the user	111	81	0.459	0.186	Maintain
	Audit and control	106	75	0.415	0.190	Maintain
	Completeness of the information	111	72	0.297	0.186	Maintain
	System reliability	109	104	0.908	0.188	Maintain
	Knowledge of the system	111	58	0.045	0.186	Remove
	Availability of information	110	85	0.545	0.187	Maintain
	System stability	108	94	0.741	0.189	Maintain
Service quality	Ease of system use	110	35	-0.364	0.187	Remove
	System flexibility	111	69	0.243	0.186	Maintain
	System integration	111	77	0.387	0.186	Maintain
	System interface	111	39	-0.297	0.186	Remove
	Accuracy of the information generated by the ERP system	111	102	0.838	0.186	Maintain
	Response time required by users	111	66	0.189	0.186	Maintain
	Attitude of system support staff	111	84	0.514	0.186	Maintain
Individual impact	Communication with the system support staff	111	74	0.333	0.186	Maintain
	Duration of system implementation	107	37	-0.308	0.189	Remove
	Experience of system support staff	111	93	0.676	0.186	Maintain
	Support team facilities	107	41	-0.234	0.189	Remove
	Training	110	80	0.455	0.187	Maintain
	User involvement	111	80	0.441	0.186	Maintain
Workgroup impact	Productivity improvement of the users	111	75	0.351	0.186	Maintain
	Improving integration between areas of the company	110	79	0.436	0.187	Maintain
	Productivity improvement of company areas	110	84	0.527	0.187	Maintain

(continued)

Table IV.
CVR values of the criteria evaluated in the research based on all the experts

Table IV.

Dimension	Criterion	Total responses	Responses to "essential"	CVR calculated	CVR minimum	Status
Organizational impact	Operational improvement of the company in virtual environments	106	44	-0.170	0.190	Remove
	Improvement of competitiveness of the company	106	78	0.472	0.190	Maintain
	Improvement of organizational culture	109	54	-0.009	0.188	Remove
	Improvement of profitability of the company	105	74	0.410	0.191	Maintain
	Improvement of revenues of the company	102	63	0.235	0.194	Maintain
	Improvement of decision-making	111	98	0.766	0.186	Maintain
	Cost reduction of the company	106	71	0.340	0.190	Maintain
	Overall user satisfaction	109	60	0.101	0.188	Remove

Note: Bold data indicate the criteria that were removed for not reaching the minimum value of CVR

cent had worked in ERP systems implementation in the energy sector. Note that, due to the fact that the range of specialists with over 12 years' experience was of a much higher proportion than those with less experience, it would have been best to break that down by requesting the age of the specialist in the questionnaire so that the tracks were better distributed.

Using CVR, we selected 25 criteria that were considered valid for large Brazilian companies. The criterion "System reliability" got the highest rating among the selected criteria, while the criterion "Ease of system use" got the worst evaluation. The following criteria were not considered valid for the successful implementation of ERP systems in large Brazilian companies: documentation, knowledge of the system, ease of system use, system interface, duration of system implementation, support team facilities, operational improvement of the company in virtual environments, improvement of organizational culture and overall user satisfaction. You can see that respondents considered that nine of these criteria (26.4 per cent) were not considered valid for the evaluation of the implementation of ERP systems in large Brazilian companies, although they are usually used.

We can evaluate the result by the company bearing the aspect for which the criteria were evaluated, as many selected criteria concern stability, security, integrity and system performance, which are naturally present requirements in large companies' ERP systems to the detriment of those criteria focused on ease of use and system interfaces. On the other hand, we can also see that the criterion "Overall user satisfaction" was not selected as a valid criterion, which confirms the view of many critics that user satisfaction is not valid as an evaluation criterion in the implementation of ERP systems.

Another point worth mentioning is that the confirmation criteria focused on the quality of service provided by the support staff to the system, which confirms the validity of the inclusion of service quality by [DeLone and McLean \(2003\)](#) as a dimension for study, as has already been emphasized previously here. However, the dimension criteria of "Duration of system implementation" and "Support team facilities" were not considered valid. The first can be understood by the inherently long-term nature of ERP systems implementations in large companies. The second criterion's dismissal can be explained by the difficulty that the key users have of perceiving its value, as it is more pertinent to the teams that support systems than those that implement them.

Regarding the dimensions, one can see that all the criteria of the dimensions "Individual Impact" and "Workgroup Impact" were considered valid, which confirms the position held by [Sedera and Gable \(2004\)](#) to keep these dimensions as previously identified by [DeLone and McLean \(1992\)](#).

It should be noted that due to the limitations of this type of study, the identified criteria can be used as a reference for future studies but should not be generalized to other situations other than those presented here. Thus, for example, as the study's focus was on identifying criteria for assessing the implementation of ERP systems in large companies, the same criteria should not be considered as valid for small- and medium-sized enterprises, and so new studies should be conducted for those purposes.

Another suggestion for future study is the identification of weights that may be applied to the criteria in certain sectors of activity, as such weights would be related directly to the company's objectives and these could also be changed according to the company's sector. Moreover, one could use the criteria and their weights in the evaluation of the implementation of an ERP system. Any such criteria may be evaluated

qualitatively or quantitatively. In that case, as suggested by Hakkinen and Hilmola (2008a, 2008b), data collection should be made at least two months after the entry into operation of the system so that the expected benefits have already been achieved and can be perceived by the interviewees.

This study aims to contribute to the international academic debate on the implementation of ERP systems presenting aspects considered important in evaluating the implementation of such systems for large Brazilian companies. Additionally, it can be used as an important source of information for managers and professionals working on the implementation of ERP systems to reduce the risks and maximize the gains of such implementations.

Finally, it is expected that companies can use the results of this study to evaluate the success of ERP systems implementation in their respective companies and that these evaluations can also serve as a basis for future studies in this area.

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Appendix 1. Criteria analysis survey form for successful assessment in the implementation of ERP systems

1. Introduction

This form is meant to examine possible criteria that may be used in the successful evaluation of the results of the implementation of an ERP system. The criteria were obtained following an extensive literature search.

The following restrictions must be considered:

- Responses should be made based only on large, national companies. Under these terms, a national company is considered to be an organized society in accordance with Brazilian law that has the seat of its administration in Brazil, and a large company or group of companies is defined as being under common control and which has in the previous fiscal year, total assets of over R\$ 240,000,000 (240 million reals) or an annual gross revenue of R\$ 300,000,000 (300 million reals).
- The person responsible for completing the questionnaire must be over 21 years old, have an undergraduate degree and must have been participating in the implementation of ERP systems for at least three years.

The information obtained from this form will be used only for academic purposes and only consolidated information obtained from the questionnaires will be published.

2. Respondent's profile

2.1 Gender

- Male
- Female

2.2 Age

- Between 21 and 29
- Between 30 and 39
- Between 40 and 50
- Above 51

2.3 Education level

- Undergraduate degree
- Lato sensu* graduate degree
- Master's degree
- Doctorate

2.4 Current role

- Key user*: responsible for the definition of how the ERP system is configured/customized.
- Consultant*: responsible for configuration/customization of ERP system.
- Project manager*: responsible for managing ERP projects.
- Executive*: Professional participant in executive positions at companies (e.g. Presidents, Directors, Managers, etc.) and have influence on the implementation of ERP systems, either on the client side or on the side of the companies that provide this type of service.

2.5 ERP system that has participated in deployments

- SAP
- Oracle
- TOTVS
- BAAN
- Other

2.6 Years of experience in implementing ERP systems

- Between 3 and 5 years
- Between 6 and 8 years
- Between 9 and 11 years
- Over 12 years

2.7 Sectors where he/she has acted in the implementation of ERP systems

- Energy
- Telecommunications
- Building
- Retail
- Financial
- Education
- Automotive
- Transport
- Industrial production
- Aviation
- Health
- Chemicals
- Media
- Government
- Other

3. Evaluation criteria

Evaluate the degree of importance of each criterion in the successful evaluation of the implementation of an ERP system in large national companies. Please consider only your experience of implementations in which you have participated. For this, use the following rating scale:

- 0: It is not important.
- 1: Important, but not essential.
- 2: Essential to be used as an evaluation criterion of success.
- NS/NC: I do not want to answer/I do not have an opinion/I cannot answer that (Table A1)

Dimension	Criterion	Description	NS/NC	0	1	2
Information quality	Understanding user information	The degree of understanding that the user has on the information provided by the ERP system				
	Documentation	The quality system documentation (user guide, manuals, etc.) necessary for the proper use of the ERP system				
System quality	Usefulness of information	The degree to which the user believes that the ERP system information are important and relevant to their tasks				
	Meeting the needs of the user	The degree of meeting the needs of users by the ERP system				
	Audit and control	The type and quality of audit and inspection provided by the ERP system				
	Completeness of the information	The scope of information provided by the ERP system				
	System reliability	The consistency of the information provided by the ERP system				
	Knowledge of the system	The degree of understanding that the user has on the functions provided by the system				
	Availability of information	The availability of information for use by the ERP system user				
	System stability	The robustness of the ERP system in order to prevent the system unavailable to users				
	Ease of system use	The degree to which the user perceives to use the ERP system does not require a great effort				
	System flexibility	The degree to which the ERP system allows to adapt to new processes, or organizational structures and/or new situations presented by the market in which the company operates				
System integration	The capacity of the ERP system to exchange information with other systems serving different functional areas or business partners, even if they are located in different geographical areas					
System interface	The layout and the flexibility of the interface provided by the ERP system					
Accuracy of the information generated by the ERP system	The degree of accuracy of the information provided by the ERP system					
Response time required by users	The time between a request initiated by the user and an ERP system response					

(continued)

Table A1.
List of criteria to be evaluated

Table A1.

Dimension	Criterion	Description	NS/NC	0	1	2
Service quality	Attitude of system support staff	The will and the commitment of the ERP system support team to support and help in using the ERP system by the user				
	Communication with the system support staff	The quality and the form of the exchange of information between the user and the ERP system support team				
	Duration of system implementation	The time spent on implementation of the ERP system				
Individual impact	Experience of system support staff	The domain knowledge and techniques presented by the ERP system support team				
	Support team facilities	The degree of updating the ERP system support staff facilities				
	Training	The amount and quality of training offered to the user in order to increase user proficiency in the use of the ERP system				
	User involvement	The user involvement level with the system so that the activities are conducted in a more proactive, more creative and more responsible, adding value to the company				
	Productivity improvement of the users	The degree of improvement in user productivity from the use of the system				
Workgroup impact	Improving integration between areas of the company	The degree of improvement of communication between areas of the company from the use of the system				
	Productivity improvement of company areas	The degree of improvement in productivity of the company's areas from the use of the system				

(continued)

Dimension	Criterion	Description	NS/NC	0	1	2
Organizational impact	Operational improvement of the company in virtual environments	The degree to which the ERP system enables improved services and new business over the internet and other virtual environments				
	Improvement of competitiveness of the company	The degree to which the ERP system provides greater benefits for the company to face competition				
	Improvement of organizational culture	The degree of improvement of organizational culture through a common vision between the different levels of the organization				
	Improvement of profitability of the company	The degree to which the ERP system allows increasing the profitability of the company				
	Improvement of revenues of the company	The degree to which the ERP system enables the increase of revenues of the company				
	Improvement of decision-making	The degree of improvement in the quality of information for decision making				
	Cost reduction of the company	The degree to which the ERP system enables cost reduction in the company				
	Overall user satisfaction	The degree of overall user satisfaction with the system so that he realizes that the functions provided by the system are adding value to their activities				

Table AI.

No. of experts	CVR minimum
5	0.877
6	0.800
7	0.741
8	0.693
9	0.653
10	0.620
11	0.591
12	0.566
13	0.544
14	0.524
15	0.506
16	0.490
17	0.475
18	0.462
19	0.450
20	0.438
21	0.428
22	0.418
23	0.409
24	0.400
25	0.392
26	0.384
27	0.377
28	0.370
29	0.364
30	0.358
31	0.352
32	0.346
33	0.341
34	0.336
35	0.331
36	0.327
37	0.322
38	0.318
39	0.314
40	0.310
41	0.306
42	0.302
43	0.299
44	0.295
45	0.292
46	0.289
47	0.286
48	0.283
49	0.280

Table AII.
CVR minimum
values

(continued)

No. of experts	CVR minimum
50	0.277
51	0.274
52	0.272
53	0.269
54	0.267
55	0.264
56	0.262
57	0.260
58	0.257
59	0.255
60	0.253
61	0.251
62	0.249
63	0.247
64	0.245
65	0.243
66	0.241
67	0.239
68	0.238
69	0.236
70	0.234
71	0.233
72	0.231
73	0.229
74	0.228
75	0.226
76	0.225
77	0.223
78	0.222
79	0.221
80	0.219
81	0.218
82	0.216
83	0.215
84	0.214
85	0.213
86	0.211
87	0.210
88	0.209
89	0.208
90	0.207
91	0.205
92	0.204
93	0.203
94	0.202
95	0.201

(continued)

MRJIAM
13,2

186

No. of experts	CVR minimum
96	0.200
97	0.199
98	0.198
99	0.197
100	0.196
101	0.195
102	0.194
103	0.193
104	0.192
105	0.191
106	0.190
107	0.189
108	0.189
109	0.188
110	0.187
111	0.186

Table AII.

About the authors

Reinaldo José de Freitas is an alumnus of Sistemas de Gestão Master Program at Universidade Federal Fluminense in Brazil. He works presently as an engineer at Petroleo Brasileiro S.A. (PETROBRAS). His research interests include decision analysis and enterprise information systems.

Helder Gomes Costa has been an Associated Professor at Universidade Federal Fluminense (UFF) in Brazil since 2006. He received his PhD degree in mechanical engineering from PUC-Rio. His research interests include decision analysis, multi-criteria decision aid, management sciences, sustainability and production planning and control. Helder Gomes Costa is the corresponding author and can be contacted at: helder.hgc@gmail.com

Valdecy Pereira has been an Associated Professor at UFF in Brazil since 2014. He received his PhD degree in production engineering from UFF. His research interests include decision analysis, organizational performance, statistics and production planning and control.

Eduardo Shimoda has been an Associated Professor at Universidade Candico Mendes (UCAM-Campos) in Brazil since 2006. He received his PhD degree in zootechny from Universidade Estadual do Norte Fluminense. His research interests include statistics, management sciences, university performance and zootechny.

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