



Prioritization of enterprise resource planning systems criteria: Focusing on construction industry

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ABSTRACT

Many organizations use integrated management systems, which are better known as ERP (Enterprise Resource Planning) systems. The use of these systems has led to the discussion of methods to evaluate them, taking into account multiple perceptions and evaluation criteria. First, based on a review of the literature regarding the implementation and application of multi-criteria models for the evaluation of ERP systems, a set of ERP system selection criteria and subcriteria is proposed for the application of ERP to companies in the construction industry, because there is a greater need to support the Brazilian civil construction organizations, where there is shortage of this type of system. Subsequently, after the validation of these criteria by a group of information technology (IT) specialists, 79 respondents drawn mainly from the construction industry and IT participated in a field study to examine their perceptions of the importance of these criteria. The study showed that the financial, business and software criteria were most important for the respondents. In addition, the importance of the subcriteria of each criteria group was also presented to assist decision makers when selecting ERP systems.

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1. Introduction

According to [Laudon and Laudon \(2007\)](#), there is a tendency, especially in large organizations, to use integrated applications or systems, i.e., systems that cover all functional areas, implement business processes throughout the company, and include all management levels. Moreover, integrated applications help companies become more flexible and productive by more closely coordinating their business processes and integrating the process groups, thus focusing on more efficient resource management and customer service.

According to [Stair \(1998\)](#), information systems have emerged without concern for data integration, but they have evolved in such a way that integration has become part of the organizational strategy.

In this context, there is a strong tendency for companies to use integrated management systems or enterprise resource planning (ERP) systems, resulting in the need for the selection and acquisition of an appropriate system among the alternatives on the market. To make this selection, different criteria, some of them subjective, are taken into consideration.

This situation occurs in different production industries, but it is aggravated in civil construction by the complexity of interconnecting

projects in this industry. It is a highly heterogeneous sector, with a great diversity of specialties and large disparities in the size of companies, increasing the complexity of systems integration among the different companies. As a result of the particularities of this industry we can mention the composition of the productive chain of Brazilian civil construction, according to research conducted in the database of the “Câmara Brasileira da Indústria da Construção” ([CBIC, 2010](#)). It is composed of Construction (Building+Heavy Construction) which occupies the highest percentage in the productive chain with 65%, followed by Materials Industry (15.5%); Trade in building materials (7.7%); Services (6.1%); Machinery and equipment for the construction (2.2%); and other providers (3.5%).

In the literature, there are several articles describing multi-criteria modeling for ERP systems selection. However, these articles are scattered among different publication sources, making it difficult to establish a global picture of the problem. Moreover, according to [Chung \(2007\)](#), even though the use of ERP systems is growing and becoming more popular, these systems are still somewhat unfamiliar in the construction industry. So, this research contributes to the state of knowledge on ERP systems selection for civil construction industry and will greatly help the managers from these companies to make decisions when selecting ERP systems.

1.1. Objective

This study aimed to examine the perception of experts regarding the importance of ERP selection criteria and subcriteria in the construction industry.

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1.2. Summary of methodology

To accomplish this objective, a questionnaire was prepared from the proposed criteria based on a literature review of multi-criteria modeling for ERP system selection. The data collected in the survey were analyzed using descriptive statistics and displayed graphically.

1.3. Structure of the article

In addition to this introduction, this article is composed of the following sections: [Section 2](#), which describes concepts in integrated management systems (ERP); [Section 3](#), which presents the methodology applied in this study; [Section 4](#), which lists a synthesis of the literature review; [Section 5](#), which proposes a set of criteria for ERP system selection, represented by a tree of criteria and subcriteria and a table with detailed descriptions of each sub-criterion at the lowest hierarchy level; [Section 6](#), which identifies the perceived importance of the proposed criteria and subcriteria using a field survey with 79 respondents; an analysis of the 79 responses and a subset of 32 respondents who implemented ERP systems or interfaces was performed, and a comparative analysis of the results from both groups was conducted; finally, [Section 7](#) presents the conclusion of the study.

2. Concepts in ERP systems

According to [Choudhury \(2009\)](#), an ERP system is a package of business software that integrates a series of modular software applications to meet all the functions of a company. [Vlachopoulou and Manthou \(2006\)](#) observed that integration is a challenging problem that has plagued the industry for many years. The authors define ERPs as company-wide systems that automate all business processes and replace legacy systems, integrating all departments and functions of a company into a single system that runs on a common database. Thus, the various departments can more easily share information and communicate with each other.

According to [Goh \(2006\)](#), ERP systems are at the heart of a company's business functions, and thus, understanding them is critical. ERPs can serve in three main capacities within an organization: operational, tactical, and strategic.

According to [Shi and Halpin \(2003\)](#), the ERP system provides a general work environment for a company to integrate its core functions of business management into a common database. Thus, information can be shared and efficient communication can be achieved among different management sectors.

There are two types of ERP systems currently available: proprietary ERP (P-ERP) and free open-source ERP (FOS-ERP). According to [Carvalho and Campos \(2009\)](#), when companies buy ERP licenses from the company that developed and owns the software, it is called P-ERP. In addition, according to these authors, in recent years FOS-ERP systems have emerged, which are software systems that can be freely distributed or sold and give the user the freedom to run the program for any purpose. It should be noted that, according to [Carvalho and Johansson \(2010\)](#), the best option for the future of FOS-ERP is the software as a service (SaaS) business model. In this model, the application itself runs remotely and is hosted on the software development company's hardware. This configuration is not new in the ERP business.

The research conducted here considers both the P-ERP and FOS-ERP systems.

3. Research method

The following steps were taken in the research process:

Step 1: A literature review to survey the state of the art within the context of the problem and to examine the theoretical references on the research topic to serve as a basis for the proposed modeling criteria.

Step 2: The compilation of criteria and subcriteria surveyed from articles found during the literature review that describe ERP systems selection using the AHP multi-criteria method or fuzzy methodology. This list of criteria and subcriteria was grouped by similarity.

Step 3: The tree of criteria from the literature review was elaborated, and a proposed set of subcriteria was grouped by five criteria (financial, business, software, technological and vendor), along with the detailed description of each criterion.

Step 4: The criteria and subcriteria sets were validated by a group of information technology (IT) specialists (“focus group”) with extensive experience in the selection of management information systems. Individual interviews were conducted, the proposed structure of the criteria and subcriteria was sent by email, and a consensus among the specialists was achieved.

Step 5: The final criteria and subcriteria sets were elaborated after validation by the focus group.

Step 6: The questionnaire was prepared and submitted via the *encuestafacil.com* tool to different groups (IT, construction industry, education and others). The questionnaire was tested and validated by experienced specialists in ERP system selection before it was forwarded to ensure that the proper research results were achieved.

Step 7: The questionnaire results from the two data samples (a group of 79 respondents and a subset of 32 respondents who implemented ERP systems or interfaces) were presented. The data collected were presented using descriptive statistics and comparative graphical analysis.

4. Literature review summary: criteria and subcriteria used for ERP systems selection

First, for the development of this work, a literature search was performed to identify and choose multi-criteria models for ERP systems selection. This search was performed using the Brazilian Federal Agency for the Support and Evaluation of Graduate Education (Coordenação de Aperfeiçoamento de Pessoal de Nível Superior—CAPES) periodicals portal, with access to SCOPUS, ISI (Web of Knowledge), and Engineering Village. The keywords initially used for the development of the research were “criteria for software selection,” “software evaluation,” and “software system evaluation.” We found 16 articles that used multi-criteria for ERP systems selection, out of which eight used the AHP method and eight used fuzzy methodology. Criteria and subcriteria from the 16 articles surveyed were compiled and separated into five tables organized by criteria group: financial ([Table 1](#)), business ([Table 2](#)) software ([Table 3](#)), technological ([Table 4](#)), and vendor ([Table 5](#)).

In these tables, the articles coded as A1, A2, A3, A4, A5, A6, A7, and A8 refer to articles based on the AHP, and the articles coded as F1, F2, F3, F4, F5, F6, F7, and F8 refer to articles that used a fuzzy approach. The authors cited are as follows: A1=([Byun and Suh, 1996](#)); A2=([Kim and Moon, 1997](#)); A3=([Teltumbde, 2000](#)); A4=([Wei et al., 2005](#)); A5=([Natalia et al., 2006](#)); A6=([Ayag and Ozdemir, 2007](#)); A7=([Lee et al., 2009](#)); A8=([Yazgan et al., 2009](#));

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