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Dynamic risks modelling in ERP maintenance projects with FCM

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ABSTRACT

Firms adopting Enterprise Resource Planning (ERP) have to maintain their applications until the end of the system life span. Proper ERP maintenance is a condition that is necessary to achieve the benefits expected of these packages. However, too many ERP maintenance projects result in failure. Numerous risks affect the development of these projects due to their size, complexity and high chance of failure. Therefore, risks management in ERP maintenance projects is a critical issue. In order to help practitioners, this paper studies the risks in this kind of projects. Particularly, we have built Fuzzy Cognitive Maps (FCMs) of ERP maintenance risks. The main advantage of FCM lies in them being capable of modelling complex phenomena based on the experts' perceptions. This tool models uncertainty and related events, imitating human reasoning. The tool proposed specifically models ERP maintenance project outcomes and risks perceptions, as well as their hidden interactions. Moreover, FCMs enable the developing of forecasting exercises through simulations. Practitioners would thus assess the joint influence of ERP maintenance risks on project outcomes. The results make known to practitioners which problems will arise if the risks are not treated, and how these will impact on the outcomes of projects. Therefore, the tool proposed would help them to manage ERP maintenance projects risks in a more effective and proactive way.

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1. Introduction

The current global situation is characterized by the interrelated, complex uncertainty, volatile and dynamic business environments. This has encouraged the appearance of critical risks that can impact on the firms' performance. In a parallel way, interest in Enterprise Risk Management (ERM) topics has rapidly grown in recent years. The ERM approach aims to handle together a spectrum of negative events with potential effects on a company's outcomes, activities, processes and resources [111], regardless of the source of the hazard (i.e., political, financial, operational, technical, among others).

The ERM approach can produce many benefits for the adopter companies, by improving operational and strategic decision-making and attaining synergies between risk management activities [4,5,30]. Hence, worldwide organizations employ this systematic approach to manage all their threats together, in an integrated way [24], in comparison to the traditional silo-based risk management approach [10]. In this way, practitioners require means and support to effectively identify, assess, treat and control their risks. In response to this demand, numerous studies have proposed frameworks, tools and strategies for rationally managing a wide variety of risks in companies (e.g., [27,76,107–110,113]). However, there is an absence of research focus on supporting risks management in the adoption of enterprise systems.

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In the last decades, ERP has been one of the enterprise systems most frequently adopted. Indeed, once this application is properly implemented, ERP can improve the business performance of the adopter firm [33], provided that its maintenance is successful [94]. ERP maintenance is a critical process carried out during the post-implementation stage. The managers of the adopting firms are too often not aware of the software maintenance importance, and they unfortunately perceive it as a non-productive and expensive activity [42,75]. However, if ERP is not properly maintained until its withdrawal, the system will not be useful [11] and the business activity of the adopter firm will be seriously hindered [94]. A defective ERP maintenance can even lead to failure in ERP adoption, being detrimental to the financial situation of the adopting firm [88,104].

The successful maintenance of ERP systems has shown itself to be a complex and difficult activity [65,101]. Indeed, the progress and outcomes of the final projects are usually uncertain and this requires facing many unforeseen events. Moreover, it has been proved that planning and control risks negatively affect the success of ERP projects [53]. To avoid undesired outcomes, practitioners have to proactively manage real ERP maintenance risks.

If practitioners manage to treat and control risks effectively, which impacts on the project outcomes, the probability of failures of the ERP maintenance project decreases [20]. In fact, a proper risks management helps practitioners to be aware of the real situation of their project, its problematic aspects and the potential existing causes for ERP project failure [43]. They will thus resolve the projects' threats more efficiently. Otherwise, improper risks management lead to the carrying out of avoidable errors and the appearance of potential problems, and this makes the achievement of the outcomes of ERP maintenance projects difficult [12,103]. Therefore, active risks management is the key to attaining the success of ERP maintenance projects.

By doing so, the identification and continuous assessment of projects risks are activities required [26]. To address this need, indicators and models have been established for helping practitioners to manage implementation risks better [21,32,116,118]. In the same line, a risk management application for the modelling, optimal adaptation and implementation of an ERP system has been developed [119]. Likewise, numerous studies have been developed addressed at identifying, evaluating and prioritizing ERP implementation projects risks [3,19,35,39,58,96,99].

Previous studies have also applied techniques such as ANOVA, the fuzzy variables set method, the Analytic Hierarchy Process (AHP), neural networks, and decision trees [19,36,37,39,102,118], for evaluating risks in ERP implementation projects. However, these tools lack certain characteristics necessary to fairly accurately model ERP projects risks. In fact, ANOVA, AHP, the fuzzy variables and decision trees method are not capable of representing all possible interactions between risks. The neural networks technique provides this requirement, although it is based on a linear structure. In consequence, the propagations follow an established pattern, limiting the feedback dynamics of the model. In contrast, FCMs lack the above-mentioned limitations, at the same time as having other features necessary to fairly accurately model ERP projects risks. These are indicated in what follows.

Despite great efforts addressed at identifying and analyzing risks in ERP implementation projects, very few ERP maintenance studies provide support to practitioners in these tasks. Nevertheless, it is critically important that practitioners assess the risks which threaten the outcomes of their ERP maintenance projects. To support ERP maintenance practitioners' work, a recent research has prioritized risks existing in each ERP maintenance project phase [94]. To do so, this individually estimates the importance of each risk. However, ERP maintenance risks are closely related and lead to dynamic behaviours, uncertainties and complexity [3,86,101]. In fact, the project risks and their interactions and possible impacts on project outcomes are normally unknown until the problems arise.

In the last decades, a large number of methods have been developed to deal with the complexity, vague information and uncertainty characteristics. These support the decision-making in different fields such as water pollution control planning, water resources management, and medical or project investment decisions, to name a few. In this line, several articles have proposed programmes which can tackle uncertainties expressed in combined multiple forms such as grey sets, fuzzy sets, discrete intervals and probabilistic distributions [38,40,59,60,100].

In addition, a technique called FCM has been proposed to represent the behaviour of complex systems fairly accurately and clarify any complex environment. To do so, this tool is based on the combination of fuzzy logic and neural networks concepts. These are capable of representing a great variety of situations, including uncertain descriptions, through the use of linguistic descriptions, vague rules or quantifiers. These expressions enable us to represent the experts' belief that cannot readily be quantified in numerical terms. Therefore, human perception is reflected in the model in a more precise way. FCMs can thus deal with the uncertainty of ERP maintenance projects. In fact, this artificial intelligence tool can be used to model complex phenomena characterized by very interrelated events (i.e., risks). Moreover, FCMs enable us to represent all possible connections and this does not limit the feedback dynamics. Likewise, this can even be used when the information is scarce. For these reasons, we have decided to apply the FCM technique for modelling ERP maintenance risks.

The rest of the paper is arranged as follows. Section 2 describes the problem existing in ERP maintenance. Section 3 indicates requirements demanded in the selection of the modelling technique and, furthermore, provides some theoretical background on the tool selected: FCMs. Section 4 explains the creation and validation of our FCM for predicting risks influences on the outcomes of ERP projects. Next, Section 5 verifies the usability of our FCM through its dynamic behaviour – in this way, possible risks scenarios are simulated and their results compared. Finally, Section 6 outlines the conclusions of the present study.

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