Expert Systems With Applications 97 (2018) 253–265

Contents lists available at ScienceDirect

Expert Systems With Applications

journal homepage: www.elsevier.com/locate/eswa

A scenario-based modeling method for controlling ECM performance

Cristina López [a,*], Alessio Ishizaka [b]

[a] University Pablo of Olavide, Department of Management and Marketing. Pedro R. Campomanes Building, Utrera road, km. 1 – 41013 Seville, Spain
[b] University of Portsmouth, Portsmouth Business School. Richmond Building, Portland Street, Portsmouth PO1 3DE, U.K.

ARTICLE INFO

Article history:
Received 4 June 2017
Revised 27 October 2017
Accepted 12 December 2017
Available online 14 December 2017

Keywords:
Enterprise content management
Decision support systems
System performance
FCM
AHP

ABSTRACT

Firms are increasingly more integrating Enterprise Content Management (ECM) into their IT infrastructure in order to manage a growing volume of complex structured and unstructured data. These packages allow capturing, generating and delivering accurate information and contents in real time to support decision making in the whole business process. However, it is not easy to achieve the full benefits of an ECM package as this relies on a variety of indicators from the organizational and technical perspectives. This paper proposes a new expert system to monitor ECM performance. It is based on the innovative hybrid technique incorporating Fuzzy Cognitive Maps (FCM) and the Analytic Hierarchy Process (AHP). As these indicators are interrelated, experts' knowledge is extracted, modeled, combined and processed in the new proposed expert system. This enables managers to precisely forecast the impact of changes in control indicators on system performance through the simulation of different scenarios over time. This approach has practical impacts as managers can make informed decisions based on the analysis of the expert system and thus prevent ECM malfunctions or misuses.

1. Introduction

In our digital era, companies face the challenge of handling vast volumes of complex information and contents arising from their own worldwide daily activities. Therefore, executive managers require help from operational support systems to identify, generate and evaluate relevant information. This is a crucial step to get a more adequate acknowledgement and treatment of uncertainty in decision support endeavors. Hence, many firms have adopted diverse decision support tools in their computing infrastructure: Enterprise Information Systems (EIS) (Leidner & Elam, 1993), Expert Systems (ES) (Luconi, Malone, & Morton, 1986), Decision Support Systems (DSS) (Sprague, 1980), and Group Decision Support Systems (GDSS) (DeSanctis & Gallupe, 1987). As technology evolves, new business analytic tools, such as Enterprise Content Management (ECM) systems, have also emerged to support the integrated wide management of all types of information and contents (Smith & McKeen, 2003; Tyrväinen, Päivärinta, Salminen, & Iivari, 2006).

ECMs are computer-based information systems that employ web technologies for capturing, processing, storing, protecting, maintaining and delivering structured and unstructured contents related to business processes (AIIM, 2010; Jan Vom Brocke, Simons, & Cleven, 2011). These solutions have the capacity to efficiently handle the whole content's lifecycle, as well as the possibility of integrating it with other sources of data. Likewise, they provide different means for analyzing the information over a wide range of managerial decisions. Thus, ECM can enhance the decision-support capabilities of adopter firms (Alalwan, 2013), as well as complying with legal requirements (Blair, 2004).

The research on ECM adoption has increased in the last years (Alalwan & Roland, 2012; Grahlmann, Helms, Hilhorst, Brinkkemper, & van Amerongen, 2012; Tyrväinen et al., 2006). Recent studies have explored the key challenges in ECM adoption (Andersen, 2008; Hullavarad, O' Hare, & Roy, 2015; Vom Brocke, Simons, Herbst, Derungs, & Novotny, 2006). Researchers have also proposed a step-by-step development process to successfully implement ECM systems (Nordheim & Päivärinta, 2006; O' Callaghan & Smits, 2005).

Once the ECM implementation is accomplished and the application is operative, the normal ECM activity can provide a wide range of benefits at an operational, tactical and strategic level (Alalwan, Thomas, & Weistroffer, 2014; Paivarinta & Munkvold, 2005; Smith & McKeen, 2003; Tyrväinen et al., 2006). Yet to achieve them, organizations have to control the performance of their enterprise systems until all bugs, misuse, etc., are corrected (López & Salmeron, 2014b). Despite its significance, this issue has received little attention.

The goal of this paper is to propose a scenario-based approach for controlling ECM performance. Our approach is based on a new knowledge acquisition technique for expert systems based on the

* Corresponding author.
E-mail addresses: clopvar@upo.es (C. López), alessio.ishizaka@port.ac.uk (A. Ishizaka).

https://doi.org/10.1016/j.eswa.2017.12.024
0957-4174/

hybrid method combining Fuzzy Cognitive Maps (FCM) and the Analytic Hierarchy Process (AHP). Many different industries have implemented expert systems (Wagner, 2017). One of the most cited obstacles to a successful development of an expert system is the problem of acquiring specific domain knowledge and representing it (Holsapple, Raj, & Wagner, 2008). In our paper, we propose FCM, which are capable of modeling a target real-world dynamic system, which may not be well-defined (Özesmi & Özesmi, 2004). Therefore, the connections between them can be represented by fuzzy weights on a linguistic scale (Kosko, 1986). Linguistic expressions are more intuitive than quantitative scales to represent knowledge. Nevertheless, the problem is how to transform this scale into a quantitative one. For this purpose, we use AHP (Saaty, 1977).

Furthermore, FCM provide mechanics to study the evolution of a scenario at successive times. This soft computing technique also enables developing "what-if" analysis to investigate alternative scenarios. For all these reasons, FCM have been successfully applied in diverse areas such as marketing (Lee, Lee, Lee, & Lim, 2013), tourism (Kardaras, Karakostas, & Mamakou, 2013), agriculture (Papageorgiou, Markinos, & Gemptos, 2009), medicine (Lee, Yang, & Han, 2012), and energy (Espinosa-Paredes, Nuñez-Carrera, Laureano-Cruces, Vázquez-Rodríguez, & Espinosa-Martinez, 2008; Kyriakarakos, Dounis, Arvanitis, & Papadakis, 2012), among many others.

In the present study, the new proposed expert system will enable the ECM performance to be forecasted by allowing relevant control indicators to interact with each other. That is, for example, how an increase in the numbers of business tasks supported by the ECM would affect system complexity. In this way, three scenarios related to technological, decision- making and organizational indicators were simulated. The results reveal that depending on managers' actions, ECM performance can be improved or damaged to differing degrees. As a result of this analysis, practitioners will be able to apply adequate response actions aimed at maintaining a proper ECM performance.

This research is organized into five sections. Section 2 presents a brief review of the ECM literature. Section 3 sets out the theoretical background of the new scenario-based method proposed. Section 4 describes a real case study where the new approach is applied. Section 5 discusses contributions from both theoretical and practical perspectives. Finally, Section 6 offers the concluding remarks and the future research perspectives.

2. Enterprise Content Management

Based on the convergence of the two previous mechanics - Document Management (DM) and Content Management (CM) - for managing unstructured information, ECM packages first appeared in the late 1990's (Boiko, 2001). This term was specifically coined in 2001 by the Association for Information and Image Management (AIIM), a global forum of information professionals (http://www.aiim.org/). Since then, it has been widely extended among key actors involved in managing organizations' digital information assets.

The ECM term is related to the integrated management of all information assets closely linked to the day-to-day conduct of business activity. These systems have been defined on many occasions from both the technical and the process perspectives. Smith and McKeen (2003) proposed one of the most referenced ECM definitions in the literature, which is: "the strategies, tools, processes and skills an organization needs to manage all its information assets (regardless of type) over their lifecycle". This definition stresses the following aspects, which characterize ECM as regards other enterprise systems:

- ECM can be considered not only as a set of isolated technologies (Jan Brocke, Seidel, & Simons, 2010), since it also implies people and processes (Blair, 2004). In fact, these solutions require the combination of strategies, processes, tools and even skills to successfully manage the content of assets in the adopter company as a single solution. Over the past few years, ECM systems have rapidly evolved in line with business technology trends such as cloud computing (Alalwan & Roland, 2012; Hullavarad et al., 2015). This has enabled content to be made internally and externally accessible (i.e., between the adopter company and its suppliers and/or customers).
- ECM packages are capable of supporting from well-structured data (i.e., reports, word processing documents, spreadsheets) to less-structured data (i.e., emails, webpages) and even non-informational assets (i.e., videos and music files) (Tyrväinen et al., 2006).
- These enterprise-wide applications manage the entire information resource lifecycle by means of web technologies and a repository (on-site or in the cloud), which is accessible via internet through a central interface. That is, ECM systems allow the capturing, management, storage, preservation, and delivery of contents and information profoundly related to the organizational processes in the most efficient way (AIIM, 2010).

ECM implementation can yield many benefits to adopter companies (Alalwan et al., 2014; Paivarinta & Munkvold, 2005; Salamntu & Seymour, 2015; Smith & McKeen, 2003; Tyrväinen et al., 2006). In order to achieve them, capabilities embedded within the system package have to fit the functionalities of the business processes in the implementing companies (Seddon & Calvert, 2010). Notwithstanding, processes are in constant change because they need to adapt to the environment's requirements. ECM should be therefore adjusted to business activities throughout its lifecycle. This encompasses the following main stages described hereafter (Alalwan & Roland, 2012).

During the adoption stage, managers have to prepare a comprehensive project feasibility study. This should detect the effects of ECM adoption on the firm performance. Iverson and Burkart (2007) present a framework for evaluating these impacts. The feasibility study should explore a wide range of issues related to ECM implementation, such as project risks, legal issues, benefits, costs, barriers and challenges of change management required. It must stress the active user support in the change management required for the successful ECM adoption (Munkvold, Paivarinta, Hodne, & Stangeland, 2003). In particular, Van Rooij (2013) describes how legacy issues need to be taken into account in the ECM adoption. Allen (2007) explains how to develop a return on investment (ROI) model when investing in an ECM system. Based on the viability analysis, decision makers will or will not implement the ECM solution.

An affirmative decision marks the beginning of the acquisition stage. This consists in looking for the ECM solution that best suits business requirements. Choosing the most suitable content management system from among the large number of options on the market is a complex and difficult process. The decision makers have to consider multiple functional and non-functional criteria of different levels of importance (Lin, Hsu, & Sheen, 2007) under the constraint of a limited budget, time and human resources. In order to support this task, several studies have proposed a framework to compare ECM tools under specific criteria (Escalona, Domínguez-Mayo, García-García, Sánchez, & Ponce, 2015; Vitari, Ravarini, & Rodhain, 2006). In the same line, Oztaysi (2014) builds a hybrid AHP-grey TOPSIS model to evaluate several ECM alternatives. Moreover, Votsch (2001) provides a taxonomy to clearly identify different kinds of content management systems.