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How to Select Knowledge Management Systems: A Framework to Support Managers

Regular Paper

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Abstract The purpose of this paper is to provide a methodological framework which could support managers in the selection of Knowledge Management Systems. The framework is based on the Analytic Hierarchy Process approach. Several aspects should draw the attention of an organization's upper level of management seeking to implement a Knowledge Management System and many specific issues have to be considered. As such, the framework has been built by making use of an ad-hoc hierarchical structure, where each singular specificity is described and compared, second-order criteria are studied and analysed, and optional decisions are highlighted and evaluated. This methodological framework offers a good applicability to different business contexts, since its hierarchical arrangement suits most of the needs of numerous organizations. Consequently, it can be regarded as a holistic approach able to assist decision makers in their Knowledge Management System selection process.

Keywords Knowledge Management, Knowledge Management Systems, Analytic Hierarchy Process

1. Introduction

In recent years, Knowledge Management (KM) has become a significant issue both in the relevant literature and in practice. Companies have strived to manage knowledge more efficiently, the primary aim of this being the improvement of performance by gaining a competitive advantage [1-5]. Knowledge is referred to as the sum of information - facts, procedures, concepts, interpretations, ideas, observations and/or judgments - that human beings can process and store in their minds [6,7]. However, this definition encompasses not only the knowledge contained in individuals' minds, but also the information existing inside single and networked organizations [8-11]. Thus, one of the most relevant issues that organizations have to cope with is that of setting up a structure for systematizing information and communication and making knowledge storable and shareable effectively.

Today the competition between companies of a global scale requires that knowledge be managed efficiently so as to get the competitive advantage necessary to succeed.

Most enterprises have acknowledged that codifying, sharing and applying this knowledge to their environment will benefit the organization. Since the development of firms' intangible assets is strongly linked to their competitive strategy, and what's more, the adopted strategy is a direct consequence of managerial decisions related to external contexts, managers' perceptions should shape knowledge resources by exploiting intangible assets in the organization [12-17].
The task of selecting the most appropriate KMS seems to be not a very easy one. Most companies have failed in their KM implementation plans when trying to find a business process to adopt for it [14,18]. Thus, it is of the utmost importance to delineate all the necessary business processes as the first step by selecting those KMS criteria which could lead to the successful implementation of the system. For this purpose, strategic considerations by managers have proven to be of the utmost importance in choosing a KMS. In fact, if the top management are aware of the context in which the KMS will be implemented they must be in thorough agreement with the achievement of the mission and goals established by the business strategies [19].

Most of the literature to date has addressed these questions by evaluating only a few KMSs [20,21]. The research work presented here aims to fill this gap by providing a comprehensive study of the most widespread KMSs on the software market.

The further aim of the paper is to propose a methodological framework, which adopts a multi-criteria approach, in order to analyse and compare KMSs by making use of pair-wise comparisons among the criteria that affect the selection process of a suitable KMS.

The paper is organized as follows: Section 2 discusses the existing literature regarding KM, KMS, and KMS selection features. Section 3 illustrates the analytic hierarchy process (AHP) building processes by defining the criteria, the sub-criteria and the alternatives within the hierarchical structure. Section 4 describes in detail how to apply the proposed framework. Finally, conclusions are drawn in Section 5.

2. Literature review

2.1 Knowledge management

Most of the several existing comprehensive definitions of KM refer to the ability of organizations to create, acquire, store, maintain and spread their knowledge. Different perspectives and a variety of approaches characterize the study of KM. Quintas et al. [22] feature KM as a process by which different types of knowledge are continually handled to meet existing and emerging needs, to identify and exploit existing and acquired knowledge assets, and to develop new opportunities. KM represents the efforts of an organization to make knowledge available within its boundaries, in order to increase the performance of the employees and the organization [23]. Therefore, the main goal of KMs is that of creating, collecting and converting individuals' knowledge in order to add value to the organization [2,24]. KM can be seen as a systematic discipline and a set of approaches which enable information and knowledge to grow, flow and generate value in an organization. In the definitions mentioned above, there is clear evidence that KM appears as a guiding force inside the organization which develops and creates organic and holistic approaches showing the usefulness and the key role of knowledge processes.

It is well known that ICT is important in contributing to the success of KM, since ICT facilitates many of the technology and people-based activities. However, it is important to highlight that effective KM practices are not always encouraged by innovative technology. According to Alavi and Leidner [25], technology supports and enhances the primary organizational processes of knowledge generation, codification, sharing and implementation. Indeed, the spread of ICT has increased the ability of firms to accelerate the emergence of a new economic, organizational and technological context referred to as the knowledge-based economy [26]. As argued by Bloodgood and Salisbury [27], ICT applications have enabled firms to select and incorporate knowledge processes regularly. At the same time, the strategic integration of IT tools has fostered business policies and business processes based on intellectual capital [28,29].

2.2 Knowledge management systems

KMSs are systematic approaches to managing organizational knowledge through ICT. KMSs include intranets, document and content management systems, workflow management systems, business intelligence tools, visualization tools, groupware and e-learning systems.

KMS integrates an extensive range of tools [30]. The goal of KMS is not to manage all the existing knowledge inside the organization, but to manage the right selected knowledge and make it readily available to help people create, store and share it inside the organization: in this way individual and organizational performance can be improved [31].

In the following section, the most widely diffused typologies of KMSs are described.

2.2.1 Document Management System (DMS)

In [32] Wakayama et al. (1998) identified the main business process enablers within an organization. Besides

people and technology, documents relating to all the enterprise's activities and processes, form a large part of the organization's record databases. Orders, invoices, queries, complaints, technical drawings of components and parts, price lists, product ranges, and legal and safety regulations chronicle the life-cycle of every organization. Since such documents can also be thought of as instruments of business transaction facilitation, enterprises are increasingly looking for as many proper methods and technologies as possible with which to guarantee the registration of the whole business process cycle. The DMS is a technology which can help with storing and distributing documents and informing people about the state of the advancement of an enterprise's activities and processes [33].

2.2.2 Learning platform (e-LP)

The use of ICT to support and facilitate learning processes is usually defined as E-learning. In general, this process can be described as the way people use an electronic device (usually a computer) together with a learning technology [34,35]. E-LP is becoming the most accepted solution for complex organizations and enterprises to develop new knowledge and skills individually or in collaboration with others [36].

2.2.3 Virtual Human Resource Management System (VHRMS)

Human resource practices can make knowledge development and application easier [37]. VHRMS can be considered as an application of IT for both networking and supporting when at least two individual, but usually collective actors, share their activities [38]. According to Lepak [39], VHRMS is characterized by a kind of networked structure based on a partnership enriched by ICT activities, which is used as a carrier to help organizations in accessing, developing and employing human capital. VHRMS includes a wide range of human capital retraining activities carried out inside organizations, such as career development activities.

2.2.4 Knowledge Portal System (KPS)

KPS is a web-based application offering single access to various sources of knowledge. These systems appear to be the best and quickest solution for knowledge and information sharing among employees [40]. KPSs optimize knowledge distribution within the entire organization and can be considered as an extension of the enterprise's information portal to KM [41]. A study analyses the functions of knowledge portals and describes seven based on their essential functions: management of heterogeneous databases and document types, structured access, customized interfaces, collaborative working, multi-level security, real-time information, and future-proofing [42].

2.2.5 Decision Support System (DSS)

Valuable knowledge is based on employees' tacit knowledge and on their social and personal interactions [43]. Usually, organizations store and up-date strategic knowledge in databases with the purpose of retrieving and using it in decision making processes using DSS tools.

2.2.6 Customer Relationship Management System (CRMS)

CRMS is the name given to all the management techniques which focus on new market concepts and market strategies (relationship marketing, one-to-one marketing, Customer Value Management), on information systems (customer services, help desks, call centres, e-mail-marketing, e-marketing, Web-marketing), and organization (re-thinking processes, promotion systems, etc.). The most important aspect of CRMS is the management of the customer life-cycle and its value.

Value is an important element in managing customer relationships when implementing marketing concepts and the wide range of considerations which underlie the cost-benefit analysis in this field are well-known. Here only some hints are given. Customers are typically considered as long-term knowledge sources, since organizations/companies estimate a prolonged, high-value relationship to be shared with them [44]. In open worldwide competitive markets, customers represent a fundamental resource. Since customers' needs are even more complex, the process of understanding those needs has become more problematic [45]. Therefore, a variety of information is built up by organizations over time so that they can have a large amount of information about their customers in order to underpin successful future relationships [46].

2.2.7 Supply Chain Management System (SCMS)

SCMS plays a role in creating profitability and a competitive advantage. It emphasizes the value of knowledge within the supply chain and enhances the strategic importance of efficient data, information or knowledge among members of the SCM network, such as suppliers, manufacturers, distributors and retailers. The SCM affects the knowledge receivers - designers, decision makers and peer agents - by supporting their decisions and their future market strategies in a more efficient way [47, 48].

2.3 Features and Perspectives of KMSs

Organizations aiming at implementing a KMS should take into consideration whether the relevant properties distinguishing a particular system could meet their requirements or not. The features proposed in literature and considered as the most suitable KMS for a company

can be classified into four essential criteria: application, cost reduction, knowledge impact and stakeholder satisfaction.

2.3.1 Knowledge impact

Another feature refers to the knowledge impact and in particular to the assessment of the environmental opportunities which can be exploited by means of the main KM processes [49]. The value of individuals rises when the use of knowledge in the KMS enables them to perform their work more effectively and satisfactorily. Therefore, this feature can be characterized by the core elements in KM processes as proposed in [50]: knowledge creation, accumulation, transfer and diffusion.

Knowledge creation

Knowledge creation assumes a fundamental and very complex role in knowledge-based organizations. It consists of the creation of new knowledge, i.e. the acquisition/identification of knowledge through external/internal sources. As shown by the knowledge spiral proposed in [24], knowledge creation is a continuously evolving and emergent phenomenon which enables companies to develop interactions, by making use of their human skills, competencies, capabilities and practices.

Knowledge accumulation

The generated and shared knowledge needs to be preserved, organized and made easily accessible. Knowledge accumulation is considered as an important element in enterprise knowledge elements, since it allows all the individuals inside the enterprise to access the knowledge base inventory. Knowledge accumulated in the enterprise plays an important role in improving management performance [51], obtaining the relevant knowledge and supporting managers' decisions.

Knowledge transfer

The knowledge transfer process matters in the distribution of knowledge among members of an organization. Knowledge transfer is a more complex process than a mere communication, since knowledge resides in members of an organization, tools, tasks, and their sub-networks and is mainly tacit or hard to express. Knowledge management has no value if created knowledge cannot be used to its full potential.

Knowledge diffusion

The last sub-criterion is knowledge diffusion, which is considered a result of successful knowledge sharing and user innovation within the organization. Knowledge diffusion involves knowledge re-creation, production and value-adding processes, by means of contextualization, projecting and compacting activities.

2.3.2 Cost reduction

Another important factor for managers when selecting a KMS is the cost factor and the economic perspective. The available budget reserved for purchasing a KMS includes maintenance, long term operating expenses and costs for user training [52]. Since costs include the expenditure associated with a product license, training, maintenance and software subscription costs, this feature can be classified into capital expenditures and operating expenditures, based on the Generally Accepted Accounting Principles (GAAP).

Capital expenses. Capital expenses are the non-recurring costs that are usually involved in setting up any proposed system. Capital expenditures are expressed in terms of hardware and software [53,54].

Operating expenses. Operating expenses are recurring costs of a KMS and include maintenance and training costs, and software subscriptions which organizations must pay for during the period of usage [53,54].

2.3.3 Application

The application of a system entails weighing its technical aspects and analysing the software or hardware specifications. This feature can be characterized by: personalization; collaboration and communication; integration; tracking and monitoring.

Personalization

Users can customize their personal profile in the proposed KMS, the so-called user interface. In addition, users can access the KMS both through internal networks (intranet) and the Internet, thus facilitating the development and exchange of knowledge between workers and managers [55,56].

Collaboration and communication

Within organizations, collaborating in solving problems, sharing knowledge, discussion, and teamwork create a significant amount of knowledge assets. Collaboration and communication create knowledge and make it possible to share it through any proposed KMS [56]. By means of a KMS, information should be revealed and could be successively managed and shared in the organization or among users within the organization environment. In addition, a KMS could store and update the knowledge inventory by means of real-time features, such as chat and video conferences, as tools for information dissemination [57].

Integration

Integration describes the ability to integrate and use different KMSs as an additional assistance giving internal

and external users the means to facilitate the creation, storage and sharing of knowledge within an organization [58].

Tracking and Monitoring

This feature refers to the application of automated communication and information processes which control and monitor users' behaviour in sharing and transferring the accumulated knowledge base [57,58].

2.3.4 Stakeholder satisfaction

Another aspect to be taken into account is stakeholders' and employees' satisfaction in terms of customer impact and human resource development, and shareholder perspective in terms of profit.

Stakeholder satisfaction should be considered as an important part of managerial decisions. This feature can be subdivided into the following perspectives: customers, employees, shareholders and suppliers.

Customers

In today's competitive markets, the definition and maintenance of good relationships with customers is one of the most important strategies for every organization. Customers should be considered as central actors in the organization: after their opinions and suggestions, the company can redesign and improve production and sales processes. Customer relations management, when integrated with the right technology, plays an important role in capturing organizational knowledge and using it to obtain a competitive advantage.

Employees

Human resources are considered a key factor in the success of any enterprise. Furthermore, in the context of KM, the employees are considered the key players in creating, sharing and capturing knowledge inside the organization. Thus, the right KMS should help companies create, share, and codify existing knowledge.

Shareholders

The use of existing knowledge within an enterprise gives the company's activities added value in terms of cost reduction, time management, human resources development, new product development and the sharing of knowledge among workers. This sub-criterion analyses these factors from the point of view of profitability and earnings [57].

Suppliers

Reputation, service and support orientation play a vital role in selecting a KMS and are considered important factors in guiding the decision maker during the selection process of a KMS provider. In addition, the quality of implementation and consulting services are particularly important if the decision maker lacks previous experience in KMS. As proposed in [10], the best way to improve the productive processes and exploit the benefits of collaboration is to capture the suggestions obtained by communication and partnerships with suppliers, thus ensuring a high rate of quality and efficiency in delivery time [59].

3. The framework used in selecting a KMS

Some elements have to be taken into consideration during the process of selecting the most appropriate KMS [60]. A preliminary analysis is necessary to characterize the business activities that the system is going to serve. Then, it is necessary to focus on the requirements the KMS should fulfil. The result of the analysis should indicate the most important features and the general set-up of the selected KMS. The appropriate KMSs which meet the criteria from the previous analyses should be identified successively. However, it is possible that the software market is not able to provide a solution that satisfies all the company's requirements. In that event, the company should select the most appropriate KMS by evaluating to what extent it satisfies their absolute requirements.

The decision-making process can be supported by multi-criteria techniques. The Analytic Hierarchy Process (AHP) is the method that best reflects judgments based on opinions and emotion, and that best prioritizes preferences for different alternatives by expressing their ranking [61,62]. Moreover, the structure and modality of AHP ensures that all the desired specifications are included in the decision process according to the decision maker's perspective.

3.1 The Analytic Hierarchy Process

The AHP, originally introduced by Saaty [63], is a flexible, structured technique for dealing with complex decisions. It is aimed at breaking down different choices arising within a hierarchical structure consisting of goal, criteria, sub-criteria and alternatives.

AHP structures the decision hierarchy from the top, where the goal of the decision maker is placed, passing through the intermediate levels (criteria and sub-criteria on which subsequent elements depend) to the lowest level (which usually is a set of the alternatives). The alternatives are placed at the bottom level of the hierarchy. The criteria and their attributes are shown in the middle levels of the hierarchy showing the evaluation process. Figure 1 illustrates the goal element, criteria, attributes and alternatives.

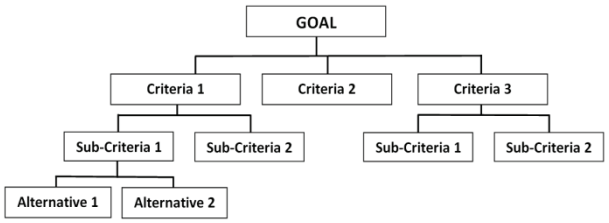

Figure 1. The generic hierarchical structure of AHP

3.2 The hierarchical structure for selecting KMS

In this section, the hierarchical structure defined to support managers in selecting the most appropriate KMS is described and illustrated.

3.2.1 Criteria and Sub-Criteria

The criteria and sub-criteria have been selected on the basis of the literature review as described in Section 2.3. Thus, the features to consider in selecting the most suitable KMS for a company can be classified into four essential criteria. For each of them the appropriate sub-criteria are provided, as described in Section 2.3:

- Knowledge impact
  - Knowledge creation
  - Knowledge accumulation
  - Knowledge transfer
  - Knowledge diffusion
- Application
  - Personalization
  - Collaboration and communication
  - Integration
  - Tracking and Monitoring
- Cost reduction
  - Capital expenditures
  - Operating expenditures
- Stakeholder satisfaction
  - Customers
  - Employees
  - Shareholders
  - Suppliers

3.2.2 Alternatives

The alternatives are at the bottom level of the hierarchy. The seven typologies of KMS identified and described in Section 2.2 represent the possible alternatives in the choice of the most suitable KMS:

- Document Management System (DMS)
- Learning platform (e-LP)
- Virtual Human Resource Management System (VHRMS)
- Knowledge Portal System (KPS)
- Decision Support System (DSS)
- Customer Relationship Management System (CRMS)
- Supply Chain Management System (SCMS)

3.2.3 The AHP-based hierarchy

Then, the complete hierarchical structure for selecting KMS appears as illustrated in Figure 2.

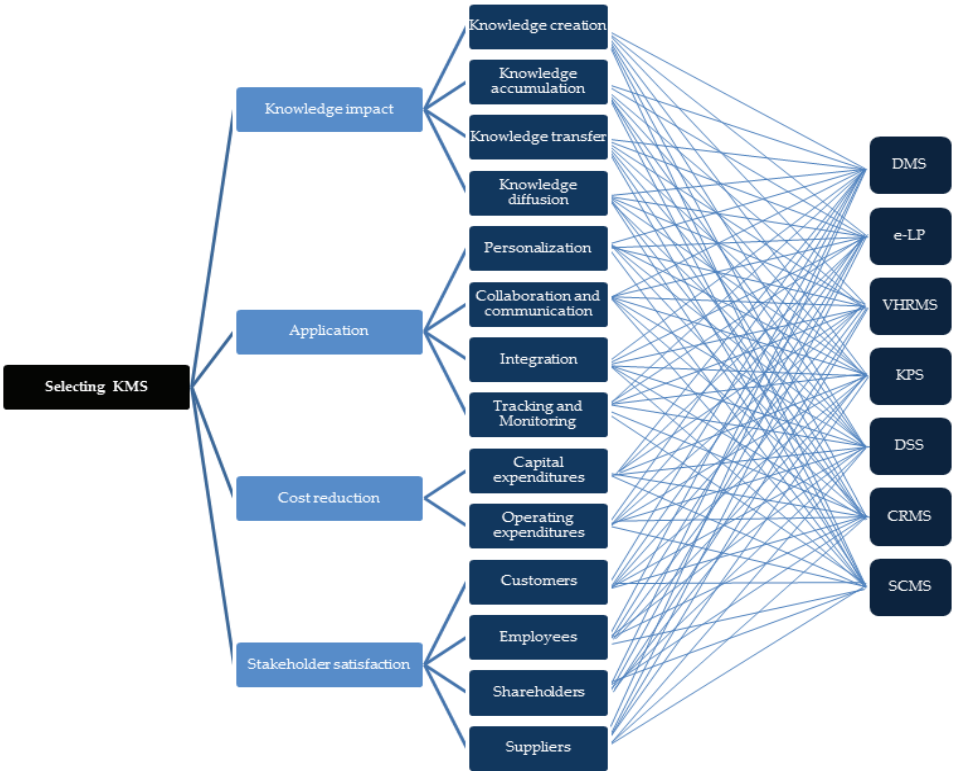

Figure 2. The complete hierarchical structure for selecting KMS

4. Application of AHP framework

Once the hierarchical structure has been defined, it is possible to start implementing the AHP in order to calculate the relative weighting of each component of the hierarchy. Then, the obtained weights are aggregated and synthesized for the final measurement of given decision alternatives.

In the hierarchy, criteria, sub-criteria, and alternatives are independent components, so that AHP is enough to calculate their weights with respect to their parent components. To do this, all the elements at the same level are pair-wise compared using the ratio scales 1,3,5,7 and 9 as Saaty suggested in [64].

Rating	Definition
9	Extremely preferred
8	Very strongly to extremely
7	Very strongly preferred
6	Strongly to very strongly
5	Strongly preferred
4	Moderately to strongly
3	Moderately preferred
2	Equally to moderately
1	Equally preferred

Table 1. The scale of judgments

Specifically, the computation of the weights is made by asking the importance of each component with respect to each of the others, at a peer level. The verbal responses are then quantified and translated into a score using the nine-point scale shown in Table 1.

To do this, a pair-wise comparison matrix is created for each level of the hierarchy. In each pair-wise comparison matrix (Table 2), rows and columns of the pair-wise comparison matrix are allocated to the components belonging to the same parent component in the decision hierarchy. The weight of component "i" compared to component "j" (a_{ij}) with regard to the parent component is determined using Saaty's scale and assigned to the (i, j)th position of the pair-wise comparison matrix [64]. Automatically, the reciprocal of the assigned number is assigned to the (j, i)th position. This procedure is repeated for all the criteria, sub-criteria and alternatives.

	i	j	…	…
I	1	$a_{i,j}$		
j		1		
…			1	
…				1

Table 2. Pair-wise Comparison Matrix

Survey to select KMS	9	7	5	9	7	5	3	3	1	3	5	7	9	3	5	7	9
With regard to the selection process of KMS:																	
Knowledge impact is preferred over **Application**																	
Cost reduction is preferred over **Knowledge impact**																	
Stakeholder satisfaction is preferred over **Cost reduction**																	
Application preferred over **Cost reduction**																	
Stakeholder satisfaction is preferred over **Application**																	
With regard to criteria Knowledge impact:																	
Knowledge creation preferred over **Knowledge accumulation**																	
Knowledge accumulation is preferred over **Knowledge transfer**																	
Knowledge transfer is preferred over **Knowledge diffusion**																	
Knowledge diffusion is preferred over **Knowledge creation**																	
Knowledge accumulation is preferred over **Knowledge diffusion**																	
Knowledge creation is preferred over **Knowledge transfer**																	
With regard to criteria Application:																	
Personalization preferred over **Collaboration and Communication**																	
Tracking and Monitoring is preferred over **Integration**																	
Integration is preferred over **Personalization**																	
Personalization is preferred over **Tracking and Monitoring**																	
Collaboration and Communication is preferred over **Integration**																	
Collaboration and Communication is preferred over **Tracking and Monitoring**																	
With regard to criteria Cost reduction:																	
Capital expenditures preferred over **Operating expenditures**																	
With regard to criteria Stakeholder satisfaction:																	
Customers preferred over **Employees**																	
Shareholders is preferred over **Suppliers**																	
Customers is preferred over **Suppliers**																	
Shareholders is preferred over **Employees**																	
Suppliers is preferred over **Employees**																	
Shareholders is preferred over **Customers**																	

Figure 3. The survey to select KMS

Broadly, the survey illustrated in Figure 3 synthesizes the questions that managers are asked to answer with regard to criteria and sub-criteria. The relative weights of the criteria and the sub-criteria are estimated by calculating the eigenvalues for their judgment matrixes with these relative weights aggregated.

Then, managers are asked to pair-wise compare all the alternatives (DMS, e-LP, VHRMS, KPS, DSS, CRMS, SCMS) with regard to all the sub-criteria of every criteria (knowledge, application, cost reduction and stakeholder satisfaction).

Once all the pair-wise comparison matrixes are formed and filled by managers, the weights of components are calculated by solving the eigenvector of the pair-wise comparison matrix. In this way, by making use of the AHP methodology, the weights are synthesized for the final measurement of the given decision alternatives.
The selection and the decision are based on the alternative KMS with the highest weight. The data analysis of the aforementioned questionnaire can be based on Expert Choice 11™, in order to calculate and synthesize the weights of the AHP hierarchy components for the final measurement of the given alternatives [65, 66].

In order to validate the performance of the proposed framework, several applications have been implemented. Individual interviews have been conducted to test the framework within specific contexts, such as: the departments of the university where the authors of the paper work, some research laboratories and companies that are partners of the universities of the authors. From this validation process, some considerations have emerged. Firstly, the framework has a reasonable application time of about two hours. Secondly, the framework has shown to be easily implementable after a concise theoretical explanation of the building concepts of the framework. Finally, at the end of each interview, it appeared evident that the implementation of the framework had allowed the interviewed manager to recognize and identify their particular needs with regards to KMS and, consequently, to select the most appropriate KMS.

5. Conclusions and implications

Rapid technological advances and market competitiveness have compelled organizations to improve their strategic capabilities by implementing KMSs. In this context, organizations are strongly recommended to select a KMS characterized by having capabilities ready for modification or change in order to cope with the creation, distribution and management of knowledge and information with the utmost speed. Therefore, the task of selecting a KMS for an organization proves to be difficult and requires a comprehensive evaluation of a wide range of features and perspectives.

The paper proposes a framework to support the decision makers in selecting the most appropriate KMS according to its criteria and attributes. Among the selected criteria and sub-criteria, the paper suggests features that characterize the KMS by its capabilities of analysing the knowledge processes, the economic aspect, the implementation troubles, and the stakeholders' participation. Unfortunately, many factors can create serious obstacles and challenges and must be addressed properly to facilitate the implementation of a KMS. In fact, rigid organizational hierarchies, cultural acceptance, staff resistance and the overlapping of initiatives can go up against the implementation of a KMS. Accordingly, before going through with the selection process, it is mandatory to fully understand the current utilized system, the organizational context and the limitations of both of them. In order to overcome all these kinds of impediments the proposed framework is based on the AHP approach. The AHP methodology is able to take on the above mentioned aspects during the decision process. It is considered as a comprehensive approach for the evaluation and synthesis of elementary criteria, based on multi-criteria evaluation and pair-wise comparison. As a consequence of the intuitive nature of the process and its power in solving complex problems, the AHP is one of the most widely used methods where both qualitative and quantitative aspects of decisions are taken into consideration among the given alternatives. The criteria described in this paper as well as the acknowledgement of the environment deriving from the survey during the application of the framework make KMS one of the more suitable tools to support managers during the process of selecting a KMS.

Finally, though the proposed framework has confirmed its usefulness and viability in the interviews conducted in the validation phase, it is important to consider the limitations that could characterize the framework. Firstly, the proposed framework could be not generalizable in every organizational context. In fact, particular needs or a specific context could induce the necessity of modifying and customizing the hierarchical structure, in terms of criteria sub-criteria and alternatives. Secondly, the necessity of first explaining to the interviewed managers the AHP procedure and the theoretical concept of the framework could represent a limitation in the application. Finally, as in each AHP-based framework, it may suffer from the inconsistency of judgments by managers thus making a moderator necessary in order to apply the methodology properly.

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