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A conceptual framework for concurrent implementation of ERP (Enterprise Resource Planning) and KM (Knowledge Management): A fuzzy TOPSIS method

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Both Knowledge Management (KM) and Enterprise Resource Planning (ERP) play crucial roles in organizations. There has been an increasing demand to implement both systems concurrently. The key characteristics of ERP and KM are quite different in their orientation; however, ERP systems focus primarily on managing physical assets while KM systems focus on leveraging innovation and utilizing knowledge assets. Because both types of assets need to be properly managed, the integration of KM and ERP becomes a strategic initiative for providing competitive advantages to enterprises. KM integrated into ERP can improve the business processes managed by ERP. In this paper, we intend to find the phases of KM and ERP implementation separately and then analyze the questionnaire, which was validated by 10 experts in this field. The questionnaire was mailed to the experts of the categorized phases of KM and ERP in just 3 stages: decision, implementation and application. Using the TOPSIS fuzzy logic method, we evaluate the mutual connection between each phase of each system in order to propose a conceptual framework for implementing ERP and KM concurrently.

Key words: ERP, KM, system implementation, conceptual framework.

INTRODUCTION

The result of the knowledge revolution is represented by a new economy- the knowledge-based economy- which is radically different from previous economic types known to mankind (Akhavan and Jafari, 2008). Considering the physical assets age, today's workforce is mobile, and technology is quickly bypassed (Jafari et al., 2007). In the past, traditional organizations focus on just physical assets, but now enterprises, especially a high-tech enterprises, have two major types of assets: physical and knowledge assets (Shuoja, 2006). Moreover, in recent years, technological/high-tech organizations are highly dependent on their intellectual capital rather than their physical assets. So there is a growing recognition that

the sources of competitive advantage of firms have been shifted away from tangible assets toward intangible assets and knowledge is considered as an enterprise's invisible asset. Many organizations spend plenty of time and money not only for understanding their invisible asset, but also for managing their intangible assets; companies such as Dow Chemical, IBM, Cigna and others are devoting some attention to understand intangible asset (Bates, 2002).

From the enterprise's point of view, managing both types of enterprise assets is highly desirable (Shuoja, 2006). Due to the fact that both types of assets need to be properly managed, the integration of KM and ERP

becomes a strategic initiative for providing competitive advantage to enterprises (Editorial, 2006). During the information era, facing a tremendous amount of data on a daily basis, enterprises only use IT to integrate use of various tools, such as intranet, data warehouse, electronic whiteboard, artificial intelligence and expert systems, making the jumbled business data well-organized and more integrated (Khandelwal and Gottschalk, 2003). It is obvious that certain methods, such as data mining can be helpful in extracting valuable information from a database, particularly when they are applied to fields such as marketing, customer relationship management, and e-commerce. Hence, IT is a crucial tool for enterprises to achieve a competitive advantage and organizational innovation (Spiegler, 2003).

Enterprises information systems such as ERP systems are developed and implemented for mainly managing physical assets of an enterprise since the 1990s. ERP systems facilitate the gathering and dissemination of information across diverse areas of business in order to generate a more accurate measure of performance. ERP software is characterized by its fluid and seamless integration of information across functional divisions and locations. This integration results in more accurate information and reporting of performance data that enables more effective decision making (Baker and Kathleen, 2007). ERP systems emphasize the efficiency of business processes in enterprises. To achieve the goals, ERP systems maintain mechanism for data/information consistency through high degrees of standardization, formalization, and specialization (Shuojia, 2006). A successfully implemented ERP can link all areas of an enterprise including manufacturing, human resource, financial management, distribution with customers and suppliers and forming a highly integrated system with shared data (Xu, 2006).

In knowledge economy, organizations are increasingly becoming aware of the need to be knowledge- focus in their organizational strategies as they respond to changes in the environment (Jafari et al., 2007). In such a highly dynamic environment, enterprises also recognize that KM is one of the most important factors contributing to business success (Shuojia, 2006). Systematic management of enterprise knowledge, e.g. new ideas, innovations and patents, has great impact on business sustainability and growth (Isaai and Ali, 2006). KM systems are information systems designed to collect, code, integrate, disseminate, and facilitate organizational knowledge. Efficient KM leads to superior business performance such as organizational creativity, operational effectiveness, and quality of products and services (Xu, 2006). Consequently, IT contributes to the integration of knowledge or even leveraging of new knowledge (Renzl, 2008). It should be noted that although IT acts as the foundation for managing knowledge assets and enables people from different departments to cooperate in its implementation, it is difficult for IT to support all the

factors that influence KM (Sveiby and Simons, 2002). Like many other types of information systems which have a high chance of failure due to both technical and human related factors, KM implementation has its own problems as well as KM-related cultural, behavioral, and strategic factors (Cooper, 2006).

Although ERP and KM are based on different management philosophies, ERP and KM systems can complement each other to some extent (Metaxiotis and Ergazakis, 2010). The distinction between information and knowledge not only suggests different implications and values for organizations, but also suggests concomitant necessity of ERP and KM systems in order to provide and leverage the respective values of information and knowledge. For businesses, the ultimate goal of such systems is nothing but to help enterprise survive in the global market by improving their performance. In short, ERP and KM systems manage the business from the point of views of physical and knowledge assets, respectively (Guo, 2006).

ERP implementation phases

The implementation of ERP system has attracted much interest. About 40% of papers on ERP focus on implementation efforts (Fang et al., 2009). Also, there are many ERP development life cycles practiced; so a general agreement on the typical phases of ERP life cycle has been attained over the past years (Wagner and Yvonne, 2004). ERP package implementation differs from traditional software development in that its success depends heavily on human aspects such as experience and knowledge. Instead of traditional paradigm that involves requirements gathering, design, and implementation, ERP implementation typically should address these issues: matching a requirement to an existing solution, gap analysis, reengineering the business, process to reduce the gap, and modifying the existing solution to fill the gap (Cao and Wu, 2009).

A generic five-stage process for ERP development incorporates design, implementation, stabilizing, continuous improvement and transformation steps. Other frameworks with the same phases but with different naming for example, initiation, planning, execution, controlling, and closing have also been proposed (Chen, 2009). In each phase of ERP development, besides specific activities peculiar to the undergoing phase, managerial activities span different phases and stages of ERP implementation including project management, people/change management, security and controls, information technology, process design and package implementation (Wagner and Yvonne, 2004). The design phase includes two inner and outer aspects. In outer aspect, the main concern of many managers is the selection of the vendor and the manner consultants can help seamless ERP implementation (Wagner and Yvonne,

2004). Consultants are helpful in bringing technical knowledge as well as the best practices from past or concurrent implementations (Cao and Wu, 2009).

Consequently, the determination of ERP software selection criteria for ERP success plays an important role while organizations consider implementing an ERP system. As selection phase is an important step in every ERP project and directly affects the system success or failure, several selection methods and criteria have been introduced by researchers (Razmi and Mohamad, 2008). Because of the importance of the selection phase, ISO 9126 standard was launched to help companies select ERP software. Key characteristics of software quality are categorized into six dimensions based on attributes such as functionality, reliability, usability, efficiency, maintainability and portability (Liang and Lien, 2007).

In the inner aspect, organizations should consider their own business characteristics such as company's vision, CIO support, ERP implementation strategies and so on. Organizations need a concrete and concise picture when they decide to implement an ERP system (Tsai et al., 2009). Analysis and design in the inner aspect should cover these activities: develop a project blueprint, establish basic requirements, identify process owners, and document how the commonwealth business processes currently work (Cao and Wu, 2009).

It is also important to have a specific plan for ERP requirement. ERP requirements driven approach consists of abstracting from the existing ERP functionality, the set of requirements that it subsumes. This will establish the link between ERP system requirements and ERP system functionality, performing the alignment at the requirements level, derived from the aligned requirements, the adaptations and extensions of the selected functionality by using the ERP requirements to functionality link (Colette and Naveen, 2001). Some other researchers call this phase chartering, where the business case for the ERP project is presented and a decision to implement is made (Markus and Tanis, 2000).

In implementation phase, following vendor selecting and finding the business process of the organization in the previous phase, the implementation team starts their job by redesigning and streamlining business processes and testing the system to ensure integrated functionality (Cao and Wu, 2009). In this phase, a lot of knowledge and a wide range of expertise are needed. These include expertise and knowledge in the functional aspects of the package, system configuration and integration, technical knowledge of the related hardware and software and project management and change management (Eleste et al., 2009). Customization should be done in this phase since it is the main phase of an ERP development process. The behavior of the ERP applications is controlled by the customization (Maintenance, 2009).

In this phase also the strategies for ERP implementation should be selected. There are a lot of strategies for implementing ERP system and also different

approaches, such as integral planning, Big-bang phased implementation and stepwise planning and phased implementation (Tsai et al., 2007). ERP implementations fall into three broad categories, which we call Comprehensive, Middle Road and Vanilla. These categories are offered as archetypes of ERP implementation. A combination of implementation characteristics serves to place an implementation within one of these three broad categories. ERP implementations differ with respect to several key characteristics: Physical Scope, the BPR Scope, Technical Scope, Module implementation Strategy, and the Resource Allocation (Parr and Shanks, 2000).

In the stabilizing phase, change management is the main concern of managers. In addition, when using an ERP system, the timely adjustment to satisfy the changing environment is also a factor influencing the ERP performance. The implementation consultants should know when to make an adjustment (Fang et al., 2009). Some other researchers call this phase shakedown phase; the phase encompasses the time between deployment and normal operation. It is during this time that controls are imposed, the system is stabilized, and staff resources are optimized to address problems (Markus and Tanis, 2000).

Some other researchers call this phase closing phase; the activities during the closing phase include integrating the completed system into daily operations, transferring responsibility to users, releasing resources, rewarding people, and conducting reviews. However, the high turnover rate of skilled professionals and globalization of the IT can further aggravate problems at this stage (Chen, 2009). In the onward and upward phases, the system enters normal operation and the organization begins to utilize the system in its day-to-day activities (Markus and Tanis, 2000).

Although researchers name two phases of ERP implementation differently, the main context is the same; all of them start with some sort of business understanding of their design or analysis. The second phase is a bit more different; while some researchers lay emphasis on deep understanding of business by separating the implementation phase from the test phase, majority of researchers mention the second phase as the implementation phase. The third phase is the more problematic phase for many managers which deals with some sort of stability; and also the main difference between ERP and other software implementation shows itself in this phase (which is human factors). So the third phase of ERP implementation is stability and adoption phase. The fourth phase of ERP implementation is maintaining the software and also supporting the ERP activities to catch the final goal of ERP implementation.

KM implementation phases

KM has many different aspects and KM is completely

Table 1. Combine Concepts of decision stage

KM phases	Fuzzy			ERP phases	Fuzzy			Combine concept	Result
Knowledge strategic plan	0.47	0.69	0.88	Strategic plan	0.62	0.91	1	Knowledge & information strategic plan	R
Identify knowledge	0.62	0.91	1	Identify process	0.59	0.87	0.99	Identify knowledge & process	R
Knowledge gap analysis	0.3	0.48	0.71	Information gap analysis	0.55	0.82	0.96	Knowledge ,information & process analyze	S

interdisciplinary in nature. Currently, some researchers are trying to find the fields which are related to KM. There are more than 40 disciplines that KM is related to (Carnes, 2002). Because of this variety, there are plenty of different frameworks. In the field of frameworks for analyzing KM strategies, some researchers argue that most approaches to KM do not adequately satisfy the KM needs of organizations, and that there is lack of cohesiveness across the various approaches. In this respect, they recommend that all KM approaches submit to the systems thinking method. Furthermore, they classify KM frameworks in three categories: descriptive, prescriptive, and hybrid. Prescriptive frameworks provide direction on the types of KM procedures without providing specific details of how the procedures can or should be carried out. Descriptive approaches describe knowledge management, and identify attributes of KM that can influence the success or failure of the initiative. Finally, hybrid approaches are a mixture of both the prescriptive and the descriptive approaches (Nakkiran and David, 2002).

While the term "knowledge management" has become overloaded with different meanings, there is a need to develop specific strategies to capture and organize knowledge assets or expertise (Abdullah et al., 2008). KM can be described in terms of attributes that flow through a structured process or life cycle, which begins at its conception or creation, and continues until it has evolved into a useful state of sharing and application (Estrada, 2001).

KM system includes strategic planning, technical and cultural foundations, knowledge resources and the processing of KM external environment (Wu and Yi-hua, 2008). A complete processing of enterprises KM should include the following parts: identify and ingather mine and store, spread and partake, employ and innovate and evaluate and wash out (Dai and Song, 2009).

For the first phase of KM, there are varieties of names: some researchers call them identify and ingather; some others mention identifying others and capturing and also some others mention creating and codifying. But they all say that in the first phase of KM, finding KM initiatives and also having some strategic knowledge plan is important. The early stage of KM preparation can be identify and ingather. Knowledge managers of the

enterprise analyze the needs of the knowledge according to environmental change and strategic plan. It is in knowledge resources activities that knowledge is collected from internal and external parts of the enterprise (Dai and Song, 2009). In this first phase early adopters followed different approaches to KM with varying emphasis on technology, cultural, organizational and managerial issues (Hansen, 1999).

In this stage, the status of organizational knowledge must be cleared; in order to regulate the purpose and scope of KM, the object of KM must be defined; in order to focus on target and control the cost in the KM process, the various constraints which include finance constraint, infrastructure constraint and time constraint must be identified; the plan of KM must be made; in order to provide a benchmark for KM, the index System of KM must be confirmed; in order to provide credible methods, audit methods and collaborative strategies must be selected; in order to avoid unnecessary resistance, the support of managers must be ensured (Wu and Yi-hua, 2008). Acquisition refers to knowledge creation and content development. This is accomplished by distilling experiences and lessons learned from client engagement projects, by collecting, synthesizing, and interpreting a variety of information (Holsapple and Joshi, 1999) (Table 1). The Know-Net method proposes the first phase combination of awareness about the benefits of KM and its relationships with strategic as well as operational and day-to-day issues in the corporate environment and KM strategic planning phase (Mentzas et al., 2001).

There are varieties of names for the second phase: some researchers call them collect while others call them mine and store and also capture. The collect stage deals with acquiring the internal and external knowledge, educational skills, fundamental theories and human experience needed to create the selected core responsibilities and knowledge domains (Abdullah et al., 2008). The mine and store phase is the knowledge value-added stage by arranging, classification and mining, especially the tacit knowledge that is deep in the personal values and mental models. In knowledge activities the processing knowledge is stored in the enterprise to spread, partake and use easily (Dai and Song, 2009).

In this stage, data should be collected according to the audit objects to be accomplished and the index system

should be determined in the planning stage. Data could be collected through questionnaires, focus groups interviews or personal interviews, expert scoring, financial statements, competitor benchmarking and statistical data in KM software system. The main source of data varied from organization to organization (Wu and Yi-hua, 2008). The Know-Net method proposes the second phase development which is the phase in which an organization transforms itself to a knowledge intensive company based on the company-specific KM value proposition derived in first phase (Mentzas et al., 2001).

The next three phases (indexing, filtering, and linking) are referred to as library management activities and include the screening, classification, cataloging, integrating, and interconnecting of content from both internal and external sources. The distribution phase includes packaging and delivery of knowledge in the form of Web pages, for example, designing knowledge displays, templates, and graphics; creation of multimedia formats. Application refers to using the knowledge that has been collected, captured, and delivered to produce products and services (Holsapple and Joshi, 1999).

The third phase is spread and partake in which the major knowledge of an enterprise is scattered in the minds of employees, especially the tacit knowledge that is highly specialized and complicated. It is the key of the enterprise KM to promote effective spread and partaking of the knowledge by certain methods and means. In order to show the highest extent of KM through knowledge spreading and partaking, this stage must enhance the marginal effect of knowledge value and promote the "external" and "spillover effect" of knowledge (Dai and Song, 2009).

Other phases include: data processing stage in which the main function of data processing stage is to distribute the large number of data from previous stage to different objects in the knowledge audit and verifies the credibility and validity of data. Because the data collected from the various aspects of organization are usually mass and disorderly, it is necessary for members of team to remove invalid, unreliable data (Wu and Yi-hua, 2008). Employ and innovate phase is the stage that enhances the personal capacity and enterprise's core competitiveness by using the acquired knowledge on the working flow and decision-making process. In the process of knowledge spreading, partaking and using, knowledge collides with each other and the edge or higher value knowledge is innovated. So, the knowledge has innovated (Dai and Song, 2009).

The select stage takes the continuous stream of collected, formalized knowledge and assesses its value. Initially, one framework should be selected as the basis for organizing and classifying knowledge to be stored in the knowledge bank. The store stage takes the nuggets of knowledge and classifies them and adds them to the departmental memory. Departmental memory resides in three different forms: in human minds, on paper and electronically. The share stage retrieves knowledge from

the departmental memory and makes it accessible to the users. The apply stage reclaims and uses the needed knowledge in performing tasks, solving problems, making decisions, researching ideas and learning (Abdullah et al., 2008).

The final phase, like many different KM projects is the maintaining and evaluating phase. There are also different phases, with different meanings for the final phase. This is the stage, which evaluates feedback of the enterprise knowledge and help enterprises do better in knowledge management. The worthless knowledge of enterprise is washed out of the enterprise and knowledge resources are added continuously (Dai and Song, 2009).

Final phase, evolve, is the refinement and continual development of existing knowledge. The create stage uncovers new knowledge through many avenues, such as feedback and analysis, research, experimentation, creative thinking and automated knowledge discovery and data mining (Abdullah et al., 2008). Measurement of the level of leveraging of knowledge assets with a KM effort should be done in the final phase with training of both the knowledge workers in the new processes and technologies as well as of the staff to take up new related knowledge (Mentzas et al., 2001).

METHODS

Because of the differentiation of the ERP and KM in their concept, it is not possible to have one by one comparison between steps; so with regard to literature, we mailed the electronic questionnaire, validated by 10 experts in this field, to categorize the activities in 3 stages of decision, implementation and application. The total number of experts that gave responses was 43. Due to missing values we concluded our findings with 38 answers from experts.

According to the conceptual method (Miles and Huberman, 1994), first and foremost, we find the concepts with regards to KM and ERP implementation literature; then due to the experts' view, we categorize the phases of ERP and KM separately in 3 stages, and then mapped the concepts to each other to find the phases which have common meanings with each other.

We also found that some phases have common concepts but some other phases refer to different meanings and concepts. Then to be able to merge the phases, we evaluated these common concepts from the experts' point of view which in the questionnaire was a Likert scale of the mutual relation between phases of each system to the other system, using the fuzzy TOPSIS method.

ANALYSIS AND RESULTS

Using the conceptual framework, we try to find the phases which refer to the concepts that are the same; so the following is seen in the decision stage. The "R" sign in the result column shows that according to the fuzzy analysis these two phases can be combined and the "S" sign in the result column shows that these two phases cannot be combined (Table 1).

The other phases are the concepts which are totally different and for implementing the systems the team should consider them separately. These phases are leadership commitment, knowledge requirement

Table 2. Combine Concepts of implementation stage

KM	Fuzzy			ERP	Fuzzy			Combine concept	Result
Design KM system such as knowledge repositories	0.57	0.85	0.98	Organizational information system development	0.61	0.88	1	Organizational information system development with respect of KM	R
Team management	0.37	0.56	0.77	Team management	0.49	0.3	0.9	Team management	R
Deploy system	0.39	0.59	0.79	Transform to the new system	0.46	0.68	0.87	Deploy system	R
Consultant participation	0.19	0.3	0.58	Consultant participation	0.35	0.54	0.77	Consultant participation	S

Table 3. Common Concepts of application stage

KM	Fuzzy			ERP	Fuzzy			Common concept	Result
Continual development of knowledge	0.31	0.44	0.7	Continues improvement	0.52	0.76	0.93	Continues improvement and continual development of knowledge and information	R
Final system acceptance	0.31	0.45	0.7	Integrate the completed system to the daily operation	0.4	0.6	0.8	Final system acceptance, integrate the completed system to the daily operation	R
Connecting knowledge between suppliers to customers	0.39	0.59	0.79	Connecting suppliers to customers	0.34	0.53	0.75	Connecting suppliers to customers	R
Reward people	0.28	0.41	0.67	Reward people	0.43	0.63	0.83	Reward people	S
Final users training and performance support	0.62	0.9	1	Transfer responsibilities to the final users	0.57	0.83	0.98	Final users training and performance support	R
Conduct reviews and closing project	0.44	0.64	0.84	Conduct reviews and closing project	0.4	0.59	0.8	Conduct reviews and closing project	R

gathering, knowledge gap analysis and information gap analysis, project plan and management, vendor selection and evaluation, reengineering, redesign business processes, develop organizational design and change readiness policies and procedures.

The following is seen in the implementation stage (Table 2). The "R" sign in the result column shows that according to the fuzzy analysis these two phases can be combined and the "S" sign in the result column shows that these two phases cannot be combined.

The other phases are the concepts which are totally different and for implementing the systems the team should consider them separately. These phases are capture organizational knowledge, package customization, integrate organizational knowledge, capture and collect organizational knowledge and document process, compose organizational knowledge, choosing ERP

implementing strategy, capture tacit knowledge, transform it to implicit knowledge, process implementation and monitoring, formalize knowledge, store organizational knowledge, indexing, filtering, linking organizational knowledge, content and information codification, knowledge audit, people/change management.

The following is seen in the application stage (Table 3). The "R" sign in the result column shows that according to the fuzzy analysis these two phases can be combined and the "S" sign in the result column shows that these two phases cannot be combined.

The other phases are the concepts which are totally different and for implementing the systems the team should consider them separately. These phases are complete knowledge map, identify process, employ and innovate new knowledge, gathering information requirements, people/change management, releasing resources.

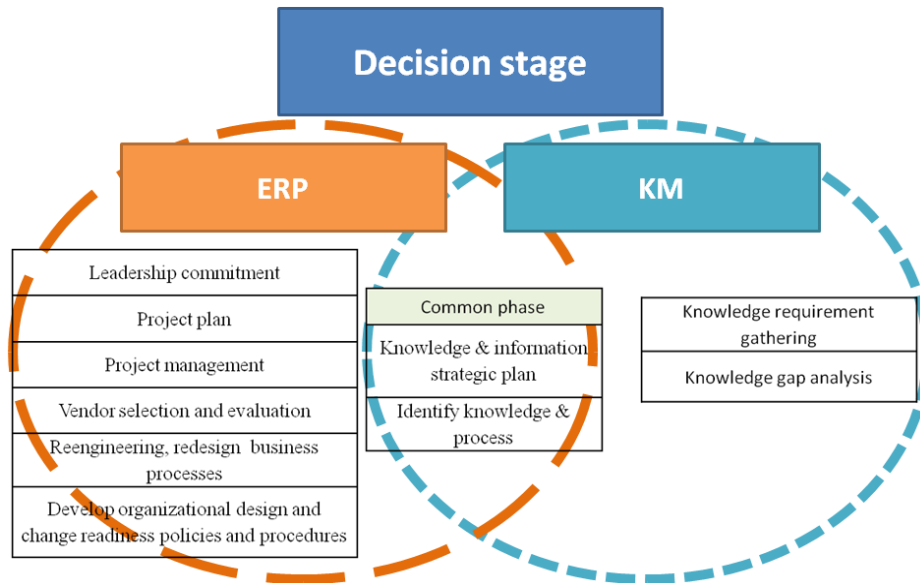


Figure 1. Phases of Decision stage

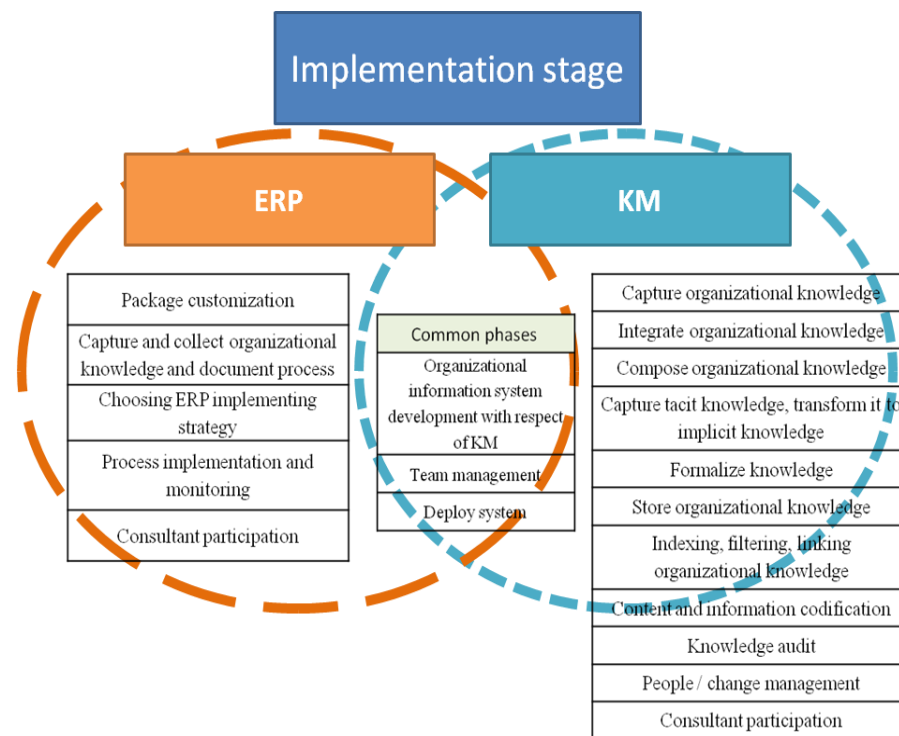


Figure 2. Phases of Implementation stage

DISCUSSION AND CONCLUSION

In this paper, first of all, we categorize the phases of ERP and KM implementation in just 3 phases of decision, implementation and application (Figures 1-3). Then in

each system we find the phases which have common concepts. And finally according to Fuzzy logic TOPSIS method analysis, we examine which of these phases can be combined together to be able to present a framework for implementing ERP and KM concurrently.

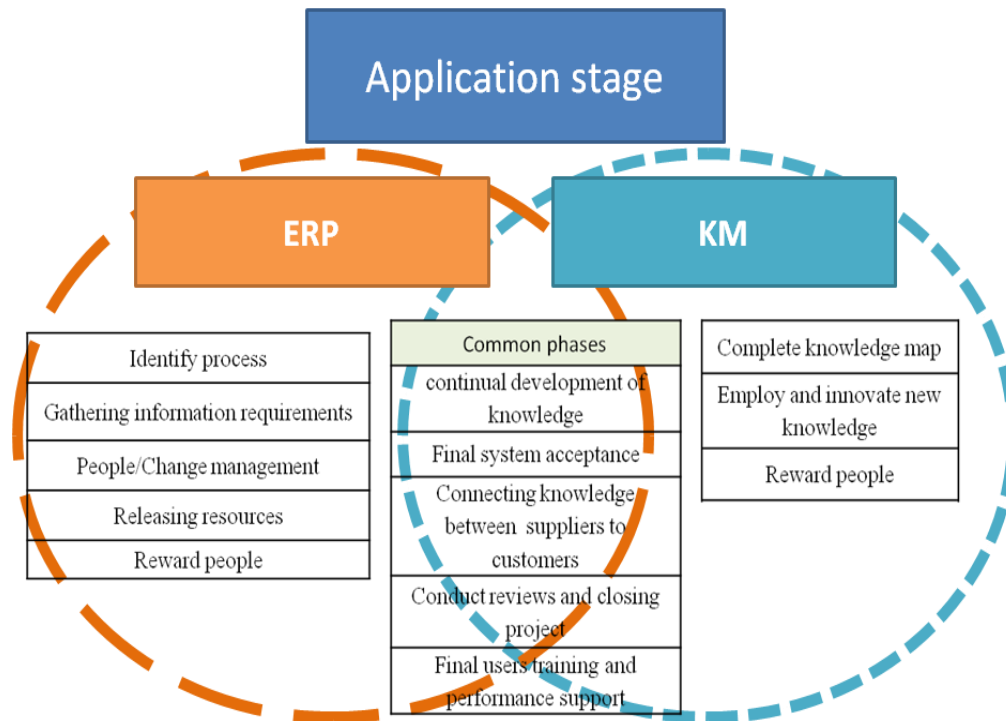


Figure 3. Phases of Application stage

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