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Using Data Mining Techniques to Develop Knowledge Management in Organizations: A Review

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Abstract: Nowadays, according to the growth of information and communication technology in society as well as the development of technologies related to data, information and knowledge, many organizations consider the importance of knowledge and ways of its acquisition, production, storage and transfer to create competitive advantage, success, and organizational survival. Measuring the position of organizational knowledge in the value chain of strategy-focused organizations is carried out through knowledge management process. This process involves the use of data and converting them into knowledge. Thus, tools such as data mining techniques are used to extract knowledge from databases. Therefore, data mining is used as a tool for the development of knowledge. Data mining is also one of the efficient tools to analyze and explore massive amounts of data in application areas. Since the current research is along with previous researches and in the same direction with its conclusion, they are generally based on library studies and questionnaire-based survey, therefore this study investigates the use of data mining techniques to develop knowledge management in organizations using library studies and review articles related to the topic. In addition, this study describes the knowledge management process and the use of data mining for the development of organizational knowledge.

Keywords: Information technology, knowledge management, data mining, data mining techniques.

1. Introduction

The organization is a goal-oriented set which follows certain system and has boundaries and limits which separate it from its environment. Nowadays competitive advantages are one of those components that guarantee organization's survival, they are not achieved randomly and without previous planning, organizations which can respond to specific work requirements of the environment and gather their trust obtain new competitive advantages and eliminate competitors from the environment. So organizations should move in this direction with contemplation and designation of scientific frameworks, competitive advantages are different characteristics which move organizations toward better services for customers, it would expel organization from the current situation and lead it toward a better position (Suhong et al., 2004).

Many organizations collect and store vast amounts of data, but they are unsuccessful in the discovery of hidden knowledge and transforming data into knowledge. Therefore, knowledge management in organizations is a challenging issue (Silwattananusarn and Tuamsuk, 2012). Knowledge has a broader concept than data and includes data and research activities related to practical use in various fields. In other hand, knowledge management is considered as a hidden factor in organizational success and means the effective use of skills and knowledge in order to reach its goals. Therefore, the intellectual capital (knowledge and experience of individuals) is used.

Effective implementation of knowledge management in organizations requires the understanding of the basic concepts such as data and information, creating appropriate infrastructure, and considering factors in organizational failure (Nazari et al., 2015). Three groups of infrastructure required for the implementation of knowledge management include the human infrastructure, process infrastructure (laws, regulations, and practices) and information technology infrastructure (network, Web site, etc.). If individual knowledge does not become group knowledge and knowledge management is not considered,

it cannot be used in organizational development (Barza et al., 2013).

In order to develop knowledge management in organizations, tools such as data mining techniques are used to extract knowledge from databases. Data mining is a bridge between statistical science, computer science, artificial intelligence, pattern recognition, and machine learning of data. Data mining in large databases is considered as an important approach for acquiring knowledge from a large number of data (Denkena et al., 2014).

So, using the power of data mining process to identify patterns and models, making the relationship between various elements in the database to discover the hidden knowledge in the data, and ultimately transforming data into information are increasingly necessary. The integration of data mining process in knowledge management solves relevant problems in organizations and supports experts' decision, resulting in solving the problems of the executive processes effectively (Silwattananusarn and Tuamsuk, 2012).

2. Methodology

Previous researches (Silwattananusarn and Tuamsuk, 2012; Amanishi and Morinaga, 2005; Folorunso and Ogunde, 2004; Alavi and Leidner, 1998) which were based on library study and questionnaire-based survey usually investigated the literature of knowledge management and the application of data mining approach for development of organizational knowledge management and obtained beneficial results. Therefore, since the current research is in the same direction of previous studies and looking for ways to utilize their findings, reviewing the previous studies and their results determines the application of data mining techniques for development of knowledge management in organizations.

So library studies approach would try to answer the following research question: can we apply data mining techniques for development of knowledge management in organizations? In addition, this study is performed with the aim of investigating the application of data mining techniques for development of knowledge management in organizations. So the discussions in the current research had been developed based on available contexts in the literature of selected articles. In the next sections of current research, some discussions about the concepts of organization competition, knowledge management, data mining and its application on the development of organizational knowledge had been introduced, then research's overall findings had been reported in conclusion section which is generally similar to published results in main articles.

3. Literature Review

Kim et al. (2016) performed data-driven scenario making by combining text mining and rule mining in fuzzy cognitive map and showed that the current data-driven scenario lead to statistical flexibility and dynamic analysis. Omotayo (2015) investigated the importance of knowledge management process as a tool for organizational management, he argued that in order to have a successful knowledge management process in an organization three dimensions should be considered these dimensions are people, processes and technology. Surbakti (2015) integrated business intelligence processes and knowledge management in order to improve the administration in business organizations, he believed that the current model is quite useful for knowledge classification and analytical applications for prediction of organizational performance. Findikli et al. (2015) investigated the role of knowledge management strategy in organizations and their corresponding knowledge management capacity and showed that strategic methods give the human resources of an organization the ability to predict organizational innovation. These techniques are related to knowledge management. Denkena et al. (2014) proved the benefits of data mining approach for knowledge based process planning via empirical sample. Garrido-Moreno et al. (2014) argued that firms should pay attention to knowledge management process and employees training beside technological infrastructures.

Tsai (2011) investigated the available researches about knowledge management process and data mining approach in a specific period of time and facilitated the current understanding about developments in knowledge management process and data mining approach. Silwattananusarn and Tuamsuk (2012) investigated the applications of developed data mining approach with respect to their implications on the knowledge management process. In this research, we have focused on collected data from questionnaire-based surveys about application of data mining on knowledge management, which were gathered from published articles between 2007-2012. The main reason for selecting this period (2007-2012) was the fact that data mining had emerged as a subcategory of knowledge management from 2006 onwards and has an important role for relationship between business intelligence and knowledge management. In addition the integration of tools, the logic of knowledge management process and applications of data mining approach had been described in this process. The results showed that it is possible to integrate data mining in knowledge management framework and improve its processes with better management. It is clear that data logy, 2(2), 129-136.

Zhen, L., Wang, L., and Li, J. G. (2013).ment and face quite a few challenges with respect to collected information and researches in the field of information systems in the future.

Sassenberg et al. (2009) investigated a data mining approach in semi-conductor industries which is based on knowledge management and proved the way a data mining approach can acquire a solution for technical problems by applying knowledge management process. Mamcenko and Beleviciute (2007) investigated the application of data mining approach for the knowledge management process in advanced learning technology and argued that the knowledge management process which is extracted by data mining can be used for finding the related information in firm's intranet. Heinrichs and Lim (2003) integrated web-based data mining tools with business models to perceive the knowledge management process in employees and showed that the interactive relationships between data mining tools and business models have a significant positive impact on employee performance capacity. Table 1 shows some of the most important researches which were performed in this field.

Table 1. Some of the most important researches with respect to subject of current study

Authors	Year	Title
Lawal et al.	2015	Application of data mining and knowledge management for business improvement: An exploratory study.
Ur-Rahman and Harding	2012	Textual data mining for industrial knowledge management and text classification: A business oriented approach.
Liu and Lai	2011	Mining group-based knowledge flows for sharing task knowledge.
Li et al.	2010	Knowledge cultivating for intelligent decision making in small and middle businesses.
Cantu and Ceballos	2010	A multiagent knowledge and information network approach for managing research assets.
Karadsheh et al.	2009	A theoretical framework for knowledge management process: towards improving knowledge performance.
Wang and Wang	2008	A knowledge management approach to data mining process for business intelligence.
Yamanishi and Morinaga	2005	Data mining for knowledge organization.
Folorunso and Ogunde	2004	Data mining as a technique for knowledge management in business process redesign.
Shaw et al.	2001	Knowledge management and data mining for marketing.
Alavi and Leidner	1998	Knowledge management and knowledge management systems: conceptual foundations and an agenda for research.

3.1. Knowledge Management in Organizations

Changes have a high rate of growth and competition grows significantly, so the appropriate knowledge management in organizations is a really important matter (Fong and Kowk, 2009), knowledge is increasingly one critical aspect of any organization. On the other hand, knowledge quite significantly depends on people and their group characteristics which is demonstrated in organizational culture and has a key and important role in the reception or rejection of knowledge management processes (Ciganek et al., 2010), generally the amount of competition between organizations in a global business environment, dynamism, uncertainty and complexity of contextual processes lead to transformation of knowledge to one of the most valuable assets in any organization. In a knowledge based economy, knowledge management is one of the main components of efficiency and organizational performance. Knowledge management is necessary for organizational survival in market competition. People and their knowledge are one of the main dimensions of organizational success and knowledge management (Omotayo, 2015), from an organizational perspective, knowledge consists of information which have an impact on performance, they are also richer than information and data and contain both of them, knowledge has a unique structure and scheduling (Berza et al., 2013).

Knowledge process includes three parts: data, information and knowledge. Data include the facts about the phenomenon. Information includes group, organizational, and data classification in the base model. Knowledge includes information from combining experience, commentary and insight which ensure the accurate measurement (Davenport and Prusak, 1998). Knowledge is divided into two groups: explicit and tacit. Explicit knowledge is objective and logical knowledge, and can be stored and classified in the form of specific documents. Explicit knowledge can be easily transmitted to others. Tacit knowledge is subjective, cognitive and experimental knowledge, and limited to the mind of the individual. Tacit knowledge is more important than explicit knowledge (Abkar et al., 2013).

Although knowledge is essential for organizational survival and the factor for the success of any organization is to achieve knowledge and understanding at all levels, many organizations do not pay attention to knowledge management seriously. Various authors with different perspectives and approaches and motivations have defined knowledge management. In general, knowledge management is defined as something that the organization needs to perform tasks and activities. In addition to a product and technology, knowledge management is considered as a method. In fact, knowledge management includes all the methods by which organizations manage their knowledge assets. Knowledge management includes the way to collect, store, transfer, deploy, update, and create knowledge (Heinrichs and Lim, 2003). Knowledge management helps organizations gain knowledge and insights through sharing their experiences, and focus their activities on the acquisition, storage and use of knowledge. Organization can use knowledge in problem solving, dynamic training, and strategic planning and decision-making. Knowledge management not only prevents the decline of intellectual property, but also continually adds to these assets. Fig. 1 shows Firestone and McElroy's knowledge management model (2005).

The term "knowledge management" is sometimes used in the sense of information technology tool. However, it should be noted that knowledge management is a more general concept of information technology and covers both IT and non-IT concept (Zhen et al., 2013). According to Gallup in 2001, tools of knowledge management not only incudes information management, but also consists of the ability to handle empowerment, capacity, and information content. Knowledge management tools create and use techniques and documentary approaches. In particular, some tools are available to instructors in this field. A comprehensive list of methods and tools for knowledge management is shown in Table 2.

In the area of modern technologies and development of businesses proportional to pace of internet and

appearance of uncertainty, the survival of businesses highly depends on movement toward globalization. Organizations are obliged to utilize the best available tools to keep their customers in competitive situations and ensure their own existence on business and organizational competition (Chandra, 2004; Nemati et al., 2004; Han and Kamber, 2000; Larose, 2006; Berry and Wiley, 2004). Since there is a great variety on customers, markets and business contexts, the accessibility of organizations to adequate information in order to make the right decision and management of organizational knowledge is necessary. So it is mandatory to implement proper solutions for classification and generation of information from a vast amount of data especially in the field of marketing. On the other hand each organization uses special sets of knowledge which are based on people's subjective ideas which guarantee their success and their absence would inevitably lead to failure, high costs of decision replication and lack of efficient use of registered experimental data which would be expected quite significantly. For this reason the leading organizations try to gather the hidden knowledge in their corresponding executive cadres and workgroups which is often called knowledge capital.

In current situation knowledge management is one of the main components of competitive advantage and its efficiency depends on the ability of an organization's management on handling this intellectual capital (Rahimi, 2011). In this context the field of data mining is a response to this necessity which lead to discovery of hidden knowledge in data and supply the required information for managers, in addition it would facilitate the development of knowledge management in organizations.

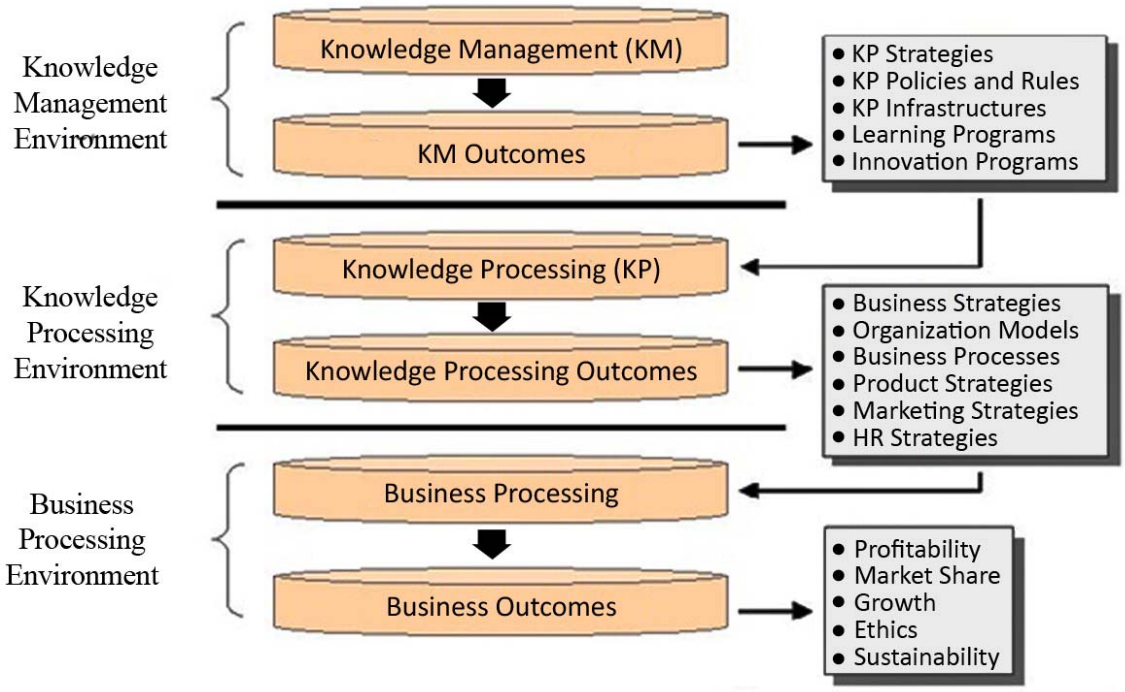

Fig.1. Firestone and McElroy's knowledge management model (2005)

Table 2. A comprehensive list of IT and non-IT methods and tools for knowledge management

IT methods and tools	Non-IT methods and tools
Knowledge bases	Learning space
Social networking service	Thinking place
Creating clusters of knowledge	Thinking space
Virtual collaborative work space	Team room
Knowledge for the exchange of information	brain storm
Advanced search tools	Learning review
Blogs and websites	Knowledge mapping
Library and documentation based on management system	Consultation with colleagues
Data mining	Use of doctrines and ideas

3.2. Concepts of Data Mining and Its Application to Knowledge Management in Organizations

Nowadays, organizations collect a vast amount of data in their data banks, the discovery of hidden patterns in this information would improve the decision making process of organizations. The discovery of knowledge in databases is often called data mining, which is performed by the goal of detecting useful information in a large collection of data (Mannila, 1996), the extracted knowledge from these data would be available for middle or senior managers as a decision support system (Baradwaj and Pal, 2011). The science of data mining applies approaches like statistics, pattern recognition algorithms for available data, neural networks and various machine learning algorithms to discover valid knowledge from a large amount of data and finally generate decision making rules (Romero, and Ventura, 2013; Cho et al., 2000). The discovery of hidden knowledge in these databases is quite similar to a process which is used for discovery of available patterns in data. Pattern in data mining is equal to the discovery of potential benefits and meaningful relationship between data. The discovery of knowledge in databases can be considered as generation of data or user's models which contain information systems or discovery of complex relationships among available data (Tang and McCalla, 2002). Fig. 2 shows different stages of data mining.

In the other hand, new information and communications technologies and decision support technologies can be effective in informing people timely and appropriately through collection, storage, evaluation, interpretation and analysis, retrieval and dissemination of information and knowledge to specific users. One of the tools used in these technologies is data mining. Data mining involves the use of advanced analytical tools to discover valid data patterns unknown in advance and relationships in large datasets (Han and Kamber, 2001). These tools include statistical models, mathematical algorithms, and machine learning methods (algorithms that automatically improve their performance through experience). Data mining means discovering new patterns from large amounts of data in a database and focuses on the extraction of useful data. Data mining includes techniques such as data classification, data mapping based on the predicted values, clustering, modeling, identification of deviations, and summarization. This approach has two goals, including description and prediction. Prediction includes variables that are unknown to identify values in the data set, and description includes a sense of human patterns and trends in data (Silwattananusarn and Tuamsuk, 2012). Data mining is beyond the collection and management of data, and includes analysis and prediction. In general, data mining refers to the analysis of data for relationships that have not previously been discovered.

These tools may include statistical models, mathematical algorithms, and learning techniques that automatically improve their performance. Data mining also uses many similar computational techniques, such as statistical analysis, decision trees, neural networks, induced modified rules, and data visualization. Considering the tools and techniques used in data mining, in particular, exploration tools such as neural networks and data visualization have had a significant impact on progress of computer sciences; the academic texts have provided different definitions for data mining. According to one of the definition, data mining is considered as a tool enabling users to make direct contact with the huge amount of data.

Some other definitions refer to mining data accurately. Some of these definitions are as follows:

- Data mining is the process of extracting reliable, unknown, and understandable information from large databases and uses it in decision-making about important commercial activities.
- Data mining refers to a semi-automatic process of analyzing large databases for finding useful patterns.
- Data mining means searching the database to find patterns in the data.
- Data mining means extraction of new reliable macro-knowledge from large databases.
- Data mining means analysis of observed data sets to find the reliable relationship between the data.

As can be seen in the various definitions of data mining, almost all definitions refer to concepts such as knowledge extraction, analyzing and finding patterns between the data. In today's organizations and companies, knowledge is considered as a helpful tool. Implementation of knowledge management supports an organization in the development of new products and important decisions in the field of strategic management. Fig. 3 shows data mining cycle.

In recent years, data mining has been considered as a tool for discovery of useful and practical knowledge. The area of data mining can be divided into four categories:

- Extraction of knowledge from a large amount of data
- Extraction of information and modeling hidden patterns from a large amount of data
- Extraction of unexpected, unknown and potentially useful information from data
- Extraction of useful information or patterns from data in large databases

Generally, data mining uses six different techniques to extract information from a large amount of data:

1. Classification: In this section, features of new data are investigated and they are assigned into pre-determined classes.
2. Statistical analysis and estimation: In this section, statistical analysis and estimation related to the characteristics of a data set are investigated and the values are attributed to the characteristics of the unknown.
3. Prediction: In this section, the future behavior is predicted to verify the classification.
4. Grouping similar rules (association rules): In this section, concurrency features related to the occurrence of a phenomenon or characteristics associated with each other in a given environment are determined.
5. Clustering: The most common form of data mining is without supervision and data are divided into different groups based on similarity to each other.

6. Indexing: In this section, users are provided with keywords to identify documentations through their analysis.

The first important issue in knowledge management is organization, dissemination, and refinement of knowledge. In the field of knowledge management, an important task is to transform tacit knowledge into explicit knowledge. Using data mining methods and techniques that are used in this field, knowledge related to the organization can be acquired by experts or different market segments (Tsai, 2013). Collected knowledge can be organized by indexing knowledge components, refinement based on content, communication and continuity between knowledge components. Then, this knowledge is integrated as a knowledge base and is distributed as a decision support system in various fields. Understanding gained in this field is used to modify existing knowledge. "For example, one of the most important risks in IT organizations is the lack of access to knowledge and resources with the required set of skills for dealing with project's demand (John, 2015)".

Changing the trend of organizations' attention from financial resources to human capital, providing high-density areas, and even explosion of information through information and communication technologies in organizations demonstrate necessity and importance of knowledge management more than ever. Extraction of the appropriate information from large amounts of data and transforming them into the required knowledge, especially in organizational decision-making, require the use of modern methods in the field. Data mining is one of these tools and approaches in the area of organizational knowledge management and discovers knowledge from databases (Shaw et al., 2001). Although knowledge is not exclusively a product of information technology, the information technology is involved in the process of knowledge creation and knowledge management from the early years. Nowadays, knowledge management is the responsibility of information technology because of playing an important role in the collection, knowledge exchange, and transfer of data, information, and knowledge. (Wickramasinghe et al., 2003).

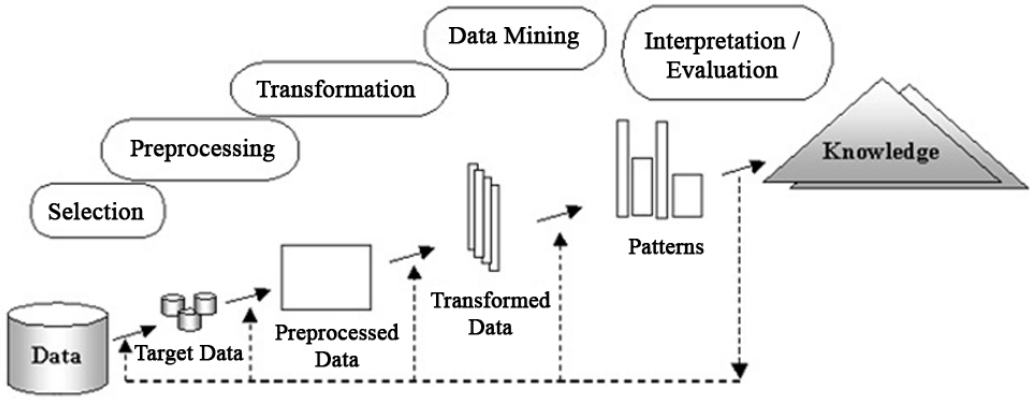

Fig. 2. Different stages of data mining

Fig. 3. Data mining cycle

4. Discussion

In this research, we have briefly discussed data mining concept and its techniques for development of knowledge management in organizations. Nowadays there is a great amount of data in any organization which doesn't have so much value for managers since they are not familiar with their utilization methods, therefore they are mostly neglected. Meanwhile, if these apparently worthless data are gathered, stored and finally explored purpose fully, a large amount of knowledge is created which support the managers of organizations in their managerial decisions. So it can be argued that data mining techniques and tools have an effective role in generation of organizational knowledge and one of the most important ones is a neural network. On the other hand organizations can acquire valuable knowledge from data mining techniques and manage it efficiently, therefore data mining and its techniques are considered as tools for development of knowledge management in organizations. Knowledge and information are the sources of business problems and knowledge management is the best chance for realization of widespread economical productivity, which lead to better human resource performance and competitive advantage. In addition, from Martensson's perspective (2000), knowledge management is an essential and important component for the organization's survival and acquisition of competitive advantage and managers and executive cadres evaluate knowledge management and develop it inside organizations in order to achieve higher efficiency and flexibility at public level.

In this regard Nemati and Barko (2004) in their researches about the impact of data mining in organizations showed how organization can use these techniques for transforming data into valuable knowledge and develop organizational knowledge management. Han and Kamber (2004) investigated the evolution of data mining with respect to its requirements and discussed its importance as a potential practical program, they focused on the relationship between data mining, discovery and management of knowledge in organizations. In addition, they described the architecture of data mining systems, multidimensional analytical databases and their relationship with data mining. In conducted study by Moayer and Gardner (2012), said that integration of data mining approach and knowledge management process increases productivity and competitiveness of organizations at the national and global level.

Also according to research conducted by Nazari et al. (2015), employee training methods and corporate responsibility in performing tasks were mentioned. Since the lack of sufficient knowledge and experience of employees in any organization leads to failure, organizations try to obtain hidden knowledge in their administrative system. According to the results of a study conducted by Hassanpour (2015), knowledge management comprises a range of processes whose output is used to access to organizational knowledge-based competitive advantage. According to the results of research conducted by Shrahi and Aligholi (2015), data mining leads to the decision model and uses various techniques, such as clustering, classification, decision trees, regression rules, and neural network.

Data mining, which has an increasing utilization would eventually lead to usage of available information in organizations and institutions for strategic decision making. So this study is an introduction for following steps of organizations to achieve intelligent systems to automate their activities by applying organizational information and transforming them to require knowledge. In such conditions they would be more successful in organizational competition. Data mining is a powerful tool which is used as the basis for acquiring the development goals of organizational knowledge management.

5. Conclusions

In recent years, technologies of production and data collection have been growing rapidly. Organizations are not faced with the problem of data collection, but their main problem is the capability to extract useful knowledge hidden in data. Thus, they should use the development of technology for effective use of this potential knowledge, and data mining techniques are considered as the appropriate response to extract this asset.

In this study, data mining tools and techniques were introduced to develop knowledge management. In answer to raised question in this research it can be argued that knowledge is one of the main components of organizational success and each organization manages it in a particular manner and is faced with challenges in this field. The process of transforming data into knowledge is not simple, and intuitive rules and broader views of society are key factors in organizational systems. Data mining allows researchers to extract hidden knowledge from raw data and predict future trends based on past trends. It should not be assumed that tools such as data mining will reduce the need for human intervention. Therefore, adjusted results obtained by such automated tools require a test to be protected against false applications. It is expected that the use of data mining techniques is effective in the development of knowledge management. Data mining allows organizations to enhance their objectives and decide based on the results of data mining.

From the perspective of knowledge management, data mining aims to discover hidden knowledge in the raw data. Any insight gained from applying the techniques of data mining does not lead to knowledge. Thus, many results include management information or organizational intelligence. For example, in commercial organizations, knowledge valuable to customer, product and market can be obtained through data mining techniques. Data mining is a useful tool for knowledge management that integrates discovery with analysis. This integration often leads to the creation of knowledge. Since artificial intelligence is one of the main components of data mining, and the amount of data daily increases with the help of computer systems and databases, the intelligent use of potential knowledge which lies in data is vital for companies in today's competitive world.

The most important limitation of this research is the lack of accessibility to perfectly related resources with respect to the subject of research which is caused by its novelty. In fact, there is not so much research about the effect of data mining on development of knowledge management in organizations and there are no fundamental theories in this domain, previous researches only paid attention to issues like data mining and knowledge management separately.

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