Impacts of Knowledge Technology on future organizations

Shaban Elahi
Assistant Professor Tarbiat Modarres University
Dr. Lavasani Ave ,Tehran, Iran (P. O. Box 19546)
+982188510555
elahi@modares.ac.ir

S. Mohsen Rahnamafard
Msc Student at ITM faculty of Tehran University
No 15, Sh.Ghanbarzadeh Ave.,Tehran, Iran
+982188510555
rahnamafrd@ut.ac.ir

Hamed Jafarzadeh
Msc Student at ITM faculty of Tehran University
No 15, Sh.Ghanbarzadeh Ave.,Tehran, Iran
+982188510555
jafarzadeh@manage.ut.ac.ir

ABSTRACT
By emergence of machine computing in 1940s we have seen more and more changes in technologies and especially in the field of Information Technology. By the last decades of twentieth century, the historical focus on information has been turned on to the knowledge. Many researches, contributions, tools and techniques have been developed based on this new trend. Knowledge technology (KT) is a new terminology appeared after this revolution. In this paper, we discuss the concept of knowledge technology and try to depict its impact on future organizations. We suggest 6 prepositions in this paper but believe there are some potential to research more about them.

Keywords
Knowledge Technology, Information Technology, Knowledge Management, Organization dimension, Structural dimensions

1. INTRODUCTION
Information Technology solutions, such as email, document management and intranets, are proving very useful in certain areas. However, many important problems still exist providing opportunities for new techniques and tools more oriented towards knowledge. New methods and tools are needed that can supplement existing technologies, but which are specifically orient towards knowledge. This would better support such key activities as knowledge creation, knowledge mapping, knowledge retrieval and knowledge use.

In this research, we are seeking the answer of these questions:

1. What is Knowledge Technology?
2. What is the future of this technology?
3. What are the impacts of Knowledge Technology on future organizations?

To find the answers of these questions, in the first part of this paper we are going to introduce a definition for KT through exploring the related texts and in the second part, we investigate the impacts of KT on organizational design based on Richard. L. Daft's framework of organization dimensions.

2. DATA TO WISDOM CONTINUUM
Much has been said and written about the distinction between data, information, and knowledge, but clear definitions are hard to make. For knowledge workers it is a problem that the terms data, information, and knowledge are used synonymously. [1] We need clear definition of these words because we will define KT based on these differentials. So in this section we briefly overview the differences between these concepts.

Data, information, knowledge and wisdom can be considered, not as discrete entities, but as existing along a continuum.

As Druker say data represents specific properties of objects (entities and events in the real world). A set of object descriptions without context is data. Data can become information when it is properly processed as structured data to serve a certain purpose. Data in context is information, and information that is applied is knowledge, i.e., experience transforms information into knowledge. [2]

Data are a set of raw numbers, objective facts or statistics about events, whereas information is processed data put in the form of audible or visible messages such as text, graphics, words or other symbolic forms. Information then becomes knowledge once it is processed and put into context by individuals [3] [4]

Wisdom goes beyond intelligence or formal knowledge. Wisdom is 'the knowledge of the knowledge'. Wisdom is knowledge tempered by experience. A person can be born with intelligence or cleverness, but wisdom is something that not all will obtain [5]

An important notion here is that knowledge involves the recognition or the understanding of patterns. This involves the creation of mental models, exemplars, or archetypes. When a pattern exists amidst the information, the pattern has the potential to represent knowledge. However, the patterns representing knowledge must have a context. The context of the pattern provides a degree of predictability as to when the pattern is applicable. [6]

Knowledge is not clear, crisp, or simple. Instead, it's muddy, fuzzy, partly structured, and partly unstructured. It's intuitive, hard to communicate and difficult to express in words and illustrations, and a good chunk of it is not stored in databases, but in the minds of people who work in your organization. [7]

We use information to describe and specify what things are. We use information to describe a situation and its context as they exist and develop. We use knowledge to evaluate and handle situations, decide how we. We use knowledge to assess, decide, problem-solve, plan, act, and monitor. [8]

Knowledge is information that is contextual, relevant, and actionable. Therefore, the implication is that knowledge has strong experiential and reflective elements that distinguish it from information in a given context. Having knowledge implies that it can be exercised to solve a problem, whereas having information does not carry the same connotation.[9]

There is a vast amount of literature about what knowledge is, so we classified and summarized all difference aspects which were written in academic text in the following table. We assume that data and information are in the same group and knowledge and wisdom have closed meaning.

Table 1. Difference between information with knowledge

Information	Knowledge
Data in context	Information in action
Relations base	Patterns base
Objective	Subjective
People irrelevant	People relevant
Conceptual	Contextual
Categorization and classification	Interpretation and inference
Structured	Fuzzy
Static	Dynamic
Accumulate during the time	Grow during the time
Tend to storage	Tend to distribute
Isolate context validation	Shared context validation
Invaluable	Valuable
Support decision making	Support Problem solving
Theory oriented	Experience oriented

3. KT LITERATURE REVIEW

3.1 Knowledge management approach

In this approach, researches being undertaken to develop a Knowledge Technology for KM.

The growing literature on KM provides a number of alternative perspectives on this, and various typologies of KM strategies and activities have been developed. Examples of these typologies include generation, codification, personalization, transferring, conceptualization, reflecting, action, reviewing, identification, collection, Sharing, adaptation and application. Confronted with these various typologies some researchers have developed a many frameworks and models which integrates them. We describe two of these models and framework in brief.

The 1st: Milton et al. developed a framework which has allowed opportunities for Knowledge Technology to be identified in support of five key Knowledge Management activities: personalization, creation/innovation, codification, discovery and capture/monitor. In developing Knowledge Technology for these areas, methods from knowledge engineering are being explored. The main work involved the application and evaluation of existing knowledge acquisition techniques and tools to support the codification of knowledge for a large intranet system. This framework currently comprises five key KM activities each of which could potentially be supported by KT. [10]

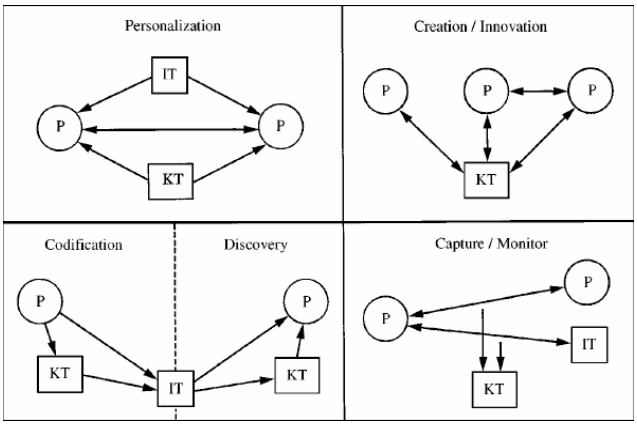

Figure 1. Milton et al KT framework

(Key: P = Person, KT = Knowledge Technology, IT = Information Technology)

The 2nd framework is Marwick framework at IBM. Selected technologies that contribute to knowledge management solutions have been reviewed using Nonaka's model of organizational knowledge creation as a framework. The extent to which knowledge transformation within and between tacit and explicit forms can be supported by the technologies have been discussed, and some likely future trends have been identified through this model. Marwick found that the strongest contribution to current solutions is made by technologies that deal largely with explicit knowledge, such as search and classification. Contributions to the formation and communication of tacit knowledge, and support for making it explicit, are currently weaker. [11]

Tacit to Tacit	**Tacit to Explicit**
E-meetings	Answering questions
Synchronous collaboration (chat)	Annotation
Explicit to Tacit	**Explicit to Explicit**
Visualization	Text search
Browsable video/audio of presentations	Document categorization

Figure 2. Marwick KT framework

3.2 Knowledge engineering approach

In this approach, researches being undertaken to define Knowledge Technology based on information intelligence.

According to Tim Berners-Lee, Director of the W3C, there will be three modern-day technology revolutions. The first occurred when the universal information space, called the Internet, was established using such technologies as HTML and HTTP. This undeniably impacted on our daily lives.

The second revolution - the XML revolution - shifted the use of the Web from being a publishing medium to serving as an application processing architecture. Perhaps the biggest result of the rise of XML is e-Business. The XML revolution has impacted every business model today. It has lead to the emergence of major new business dynasties and changed the playing field forever.

So, what's the third revolution? Can information technologies have another trump card waiting to be played? The answer is YES. We are at the dawn of the third revolution - where it is the rise of the Semantic Web. This shift of the Web from an information-based structure to a knowledge-based structure will revolution our industry — just like HTML and XML did earlier. This new revolution will introduce "knowledge technologies" to our community.

In this approach knowledge technology is one that adds a layer of intelligence to information technology, to filter appropriate information and deliver it when it is needed.

The term knowledge technologies refers to a fuzzy set of tools including languages and software enabling better representation, organization and exchange of information and knowledge.[12]

1st conference of KT was held in Austin, USA in March 2001 introduced topics of conference as below:

1. Knowledge Acquisition
2. Knowledge Modeling
3. Knowledge Interchange
4. Knowledge Access and Navigation
5. Topic Maps and XTM
6. Anthologies and Taxonomies
7. The Business of Knowledge
8. Resource Description Framework
9. Electronic Media Management
10. Semantic Web

With the aid of above classification and other ones suggested in the 2nd conference of KT was held in Seattle, USA in March 2002 and research of Skyrme association [13], the below classification can be introduced:

1. Knowledge Representation/Artificial Intelligence
2. Knowledge Organization/Libraries
3. Internet/Semantic Web
4. Document/Asset Management
5. Knowledge Management /Knowledge Base System
6. Expert Systems/Agent Computing
7. Machine Learning /Robotics

3.3 Knowledge society approach

In this approach, researches being undertaken to suggest Knowledge Technology for future knowledge society.

Information Society Technologies (IST) (thematic priorities in the EU's sixth Framework Program 2002-

2006) addresses the vision of ambient intelligence, in which "people will be surrounded by intelligent and intuitive interfaces embedded in everyday objects around us and an environment recognizing and responding to the presence of individuals in an invisible way" (ERCIM News). KT will specifically research advanced ways to improve the flow of knowledge across the emerging Webs and networks, whether it is embedded in multimedia content or implicit in human communications.

The objective is to provide automated solutions for creating and organizing virtual knowledge spaces (e.g. collective memories, digital libraries) so as to stimulate radically new content and media services and applications.

Work will focus on technologies to support the process of acquiring and modeling, navigating and retrieving, representing and visualizing, interpreting and sharing knowledge. These functions will be integrated in new semantic-based and context aware systems including cognitive and agent-based tools. Work will address extensible knowledge resources and anthologies so as to facilitate service interoperability and enable next-generation Semantic-web applications. Research will also address technologies to support the design, creation, management and publishing of multimedia content, across fixed and mobile networks and devices, with the ability to self-adapt to user expectations. The aim is to stimulate the creation of rich interactive content for personalized broadcasting and advanced trusted media and entertainment applications. [14]

4. DEFINITION OF KT

By exploring IT definitions, we fined two approaches about it. First is narrow approach and second one is broad approach.

Information technology, in its narrow definition, refers to the technological side of an information system. It includes the hardware, databases, software, networks, and other electronic devices. It can be viewed as a subsystem of an information system. [15]

But in broadest definition, the term information technology is used interchangeably with information system. That is an organization's collection of information systems, their users, and the management that oversees them. Or in other terms interrelated components working together to collect, process, store, and disseminate information to support decision making, coordination, control, analyses, and visualization in an organization. [16]

As the same as IT literature, when we talk about KM, indeed we talk about a broadest concept of knowledge and impacts of it on our life. This concept of knowledge management is not new in information systems practice and research. However, radical changes in the business environment and limitations of the traditional information system lead to suggest knowledge management. [17]

But when we are talking about KT we intend to present a concept focused on technology and tools independent from the other components of system such as people, process and etc. (table 2)

Table 3. Definition of KT Vs. IT

Approach / Area	Narrow (Technical)	Broad (Systemic)
Information	IT	IT/IS
Knowledge	KT	KM

Wikipedia encyclopedia defines IT in narrow approach as:
"Information technology (IT) or information and communications technology (ICT) is the technology required for information processing. In particular the use of electronic computers and computer software to convert, store, protect, process, transmit, and retrieve information"

We define KT with the aid of this definition and based on "knowledge life cycle" functions which presented in the many KM researches. For example Turban et al describes these functions in six items; Create, Capture, Store, Manage and Disseminate. [15]
So in our definition *KT* is "the technology required for knowledge processing. In particular the use of hardware and software to create, capture, refine, store, manage and disseminate knowledge". It means the term knowledge technologies refers to a fuzzy set of tools including languages and software enabling better representation, organization and exchange of information and knowledge.

5. KT IMPACT ON ORGANIZATION

Now we are going to investigate "How" KT impact on organizational dimensions.

To this end, we extracted IT impacts on organization from reputed texts in the field of information technology and organization theories and use it as a pattern to investigate KT impacts. We also survey more texts around future knowledge-based world and explore inherent difference between information and knowledge in details to enrich our study.

To determining organization dimensions, we used the famous framework of Richard L. Daft which introduced the "structural dimensions" of organization as below:

Formalization pertains to the amount of written documentation in the organization. Documentation includes procedures, job descriptions, regulations, and policy manuals. Formalization is often measured by

simply counting the number of pages of documentation within the organization.

Specialization is the degree to which organizational tasks are subdivided into separate jobs.

Hierarchy of Authority describes who reports to whom and the span of control for each manager.

Centralization refers to the hierarchical level that has authority to make a decision. When decision making is kept at the top level, the organization is centralized.

Professionalism is the level of formal education and training of employees. Professionalism is generally measured as the average number of years of education of employees.

Personal Ratios refer to the deployment of people to various functions and departments. Personnel ratio includes the administrative ratio, the clerical ratio and the professional ratio. [18]

As illustrated in table 4 we compare the IT and KT impacts on these dimensions and in the rest of this research we discussed KT impacts of each dimensions in more details:

Table 4. Framework of IT/KT Impact

	IT Impact	KT Impact
Formalization	IT-document	JIT-document
Specialization	Specialized Departments/ Specialized Staff	Machine Specialization/ Meta specialized staff
Hierarchy of Authority	Wide span control	Machine point Control
Centralization	Decentralized Decision Making	Post Centralized Decision Making
Professionalism	Mass-oriented	Geniuses-oriented
Personal Ratio	5-part structure	2-part structure

5.1 Formalization

During the IT ages the formalization in organization decreased. Because of use of electronic devices and computers bureaucracy fell down in minimum level. Porter describe this reality with this words "Aided by an electronic bureaucracy, customs and immigration are streamlined and goods move freely around the world" [19] So there is less need for large amount of physical documents but we still need electronic documents, procedures and instructions to cope with organization activities, we could call them *IT-documents*.

In knowledge space we will have Just in time documents (*JIT-documents*). That is mean when you need any document, it construct from scratch. It's possible with the ability of some knowledge technologies such as semantic web, agents, digital library and digital object library (DOL). So in this space we don't have many documents to store and manage, but we must be able to manage DOLs or sharable content object (SCO) which is handled with computer agents. [20]

Furthermore, many tasks are handled by intelligent computerized systems (instead of human) and there is no need to document the method of performing them.

5.2 Specialization

Since machine computing was emerged and organizational technology grew more complex, the complexity of the organization increased as well. Many firms are adding CIO, and some create whole new departments to help the organization manage and keep pace with rapidly changing of information technology. In addition, when companies become involved in activities such as e-commerce, the need for specialist staff greatly increased. [18]

As a result, the demand for managers with specific technical skills is increasing, while the demand for general business manager is declining [21]

But what will happen when knowledge technologies appear?

In the field of KT, because of the availability of technologies like expert systems, knowledge based system (KBS), robots and agents; we lead to the new concept of *machine specialization*.

With machine specialization, the role of production work, processing materials, has steadily diminished and will virtually disappear as a result of widespread use of robots. Service workers such as restaurant staff, hairdressers and teachers have also become a larger part of the workforce than in the past. But it is not difficult to conceive of robot hairdressers, cooks and masseuses, although many may still prefer the ministrations of humans. [22]

It is necessary to pay attention that in knowledge society, the minority of workers will be engaged in knowledge work doing very high-level job. So we have people and department with not only specialty but also with much innovation and creativity with a systemic approach toward world. We name this *Meta specialization*

5.3 Hierarchy of Authority

IT allows increased productivity of managers and increased span of control due to less need for supervision. This trend is already evidenced by the continuing phenomenon of the shrinking size of middle management [15]

In the first view, with KT there will be a more decline in the scope of central control and a larger degree of autonomy in the dispersed units. [22]. This would be the result of reduction in the total number of employees as a result of increased productivity and because of the ability of lower-level employees to perform higher-level jobs (e.g., by using ES and AI). [15]

But if you look deeper, in the viewpoint of knowledge society, we will have a society that be surrounded by intelligent machines. Michael L. Dertouzos in his futurism book talk about human-centric computing, in which the computer isn't a single device but a room where computing is around you and in the air. [23] in the "Minority Report" movie, Steven Spielberg showed the events take place in the year 2054 when robots can control and mange all aspect of organization alone.

So it seems in this space, where knowledge systems and agents can control most aspects of our life, the concept of hierarchy of authority will be vanished. And mangers delegate all works to reliable machines and their control span concentrate on only one point; *machine point control*.

5.4 Centralization

Advanced information technology has enabled organizations to reduce layers of management and decentralize decision making. Information that may have previously been available only to top managers at headquarters can be quickly and easily shared throughout the organization, even across great geographical distances. People and groups no longer have to be located under one roof to collaborate and share information. An organization may be made up of numerous small teams or even individuals who work autonomously but coordinate electronically. [24]

People like to plan, but life is actually driven by events and at the moment most of the technology give information but they generally don't make decisions for people. But now The KT tools help to move from the current mode of browsing and gathering information, to decision support with high level technologies like ES and Agents where decisions are made for us. [25] As impact of this new trend, middle level decision making will completely delegated to intelligent technologies, and only few decision makings will remain for top managers and centralized in headquarter. We name this new trend as *Post centralization.* It's important to notice that IT decentralization embedded in this new centralization.

5.5 Professionalism

The implementation of sophisticated information technology systems means that organizations need more people with professional education and knowledge to use and maintain the systems. The information services department is highly professional and required a level of technological proficiency on the part of its staff. [26]

By emerging of KT paradigm, the meaning of professionalism is completely changed. Academic learning will be substituted with *continues learning.* So formal educational degrees will be disappeared and all employees should be trained during the life of their work.

On the other hand as discussed above, in the future nearly all standard clerical work will have been relegated to computers; some humans will be occupied in developing new knowledge and designing its application by machines, [22]

So we will have two types of employee. First low level ones which need not professional education to do simple work with the aid of machines. Other ones called high level people who are very professional and are trained in a *Genius-oriented* educating system to deal with the complexities of twenty-first century technologies. By this revolution, it seems in the future bachelor's degree is insufficient and will be omitted from formal educations. [20]

This trend is similar to He/She theory in the management theory text as new ecology of work in the future. [27]

5.6 Personal Ratio

During these last decades the ratio of staff to line workers in most organizations has increased with clerical jobs being replaced by computer systems and with an increased need for information system specialists to cope with the systems.

By Emerging of KT tools, especially ES, May reversed this trend. Specifically, the number of professionals and specialists could decline in relation to the total number of employees in an organization [15].

On the other hand, many jobs have fallen under the axe of advanced technologies, as most clerical, administrative and middle-management jobs are replaced by Knowledge-based systems. If we want explain this reality with Mintzberg *5-part organization structure* theory; technical support staff, middle line and administrative support staff will be replaced by intelligent systems and the top management and technical core will be remain as a high level and low level *2-part organization structure.*

6. CONCLUSIONS

In this research we have tried to look at futurism from academic point of view and represent a new definition of the term Knowledge Technology (KT). Then we investigated the impacts of this new concept on organizational dimensions. In this research we've only

worked on structural dimensions, but it seems necessary to work on contextual dimensions of organization including size, technology, environment, strategies and culture to gain deeper perception of future organization. Furthermore, Even if the paper faces important problems, it remains a description of what will happen with the introduction of knowledge technology. No technical aspects are considered. It would have been interesting to analyze some results we obtained, during the application of the presented concepts in a real case study.

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