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Yet Another Classification of ICT in Knowledge Management Initiatives: Synchronicity and Interaction Perspective

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Absract: Today, the computational power and storage volume allow processing of large volumes of data and processing it within minutes or seconds, performing analyses and creating information. Enriched with context, information may be turned into knowledge. This information and knowledge are used for decision support and introduction of new operational tasks in business organizations and academic institutions. This study analyses the application and implementation of ICTs in knowledge management and classifies ICTs into several categories based on extensive literature research. It also provides an original type of classification that connects synchronicity and interaction and main classification criteria. A better understanding of ICTs aimed by this classification may lead to technological knowledge management implementations and applications based on advantages of involving ICTs in processing operations.

Key words: Knowledge management, information and communication technology, classification, knowledge, synchronicity, interaction

INTRODUCTION

Already in the earliest signs of human existence, people communicated with one another. Through the decades and centuries, people were developing various methods and channels for communication. With the beginning of the current digital era, Information and Communication Technology (ICT) was developed that allows not only communication but also automated capturing of data, its storing and processing. ICT has brought about revolutionary changes in the way people work, communicate, learn, spend time and interact (Jorgenson and Vu, 2016). In recent decades no technology has had a global impact on the same level as ICT (Nayef and Rodhan, 2011). ICTs bolstered productivity more effectively than earlier technologies (Perez and Lopez, 2016).

Today communication is a basilar process for business and is a very important dimension of working in virtual environment (Goncalves *et al*., 2014). ICT provides the base for computer applications to execute business processes (Broadbent and Weill, 1997). Capital per worker, mobile cellular and telecommunication technology are the dominant drivers of output per worker and hence have relatively high contributory power to support the long-run economic growth (Kumar *et al*., 2016). ICT offers now large spectrum of possibilities that changed the way, we live, perceive and imagine. ICT became a substantial part of our life.

This study aims to add to the knowledge in the field of ICT impact on knowledge management in business organizations by performing an extensive research through analyzing ICT in knowledge management applied, so, far. This paper classifies the ICTs into categories based on the attributes of selected ICTs to enhance the perception of given ICTs that may lead to efficient application and implementation of available technology. The main purpose is to inspire future research on the application of ICT in knowledge management domain and to advance future knowledge in the field of ICT application and its implementation in business organizations.

This study is organized as follows. Next section describes applications of ICTs in various aspects of knowledge management used, so, far in business organizations and discusses the potential impediments and opportunities for future exploiting of the use of ICTs in the field of knowledge management. The consequent section provides classification of known ICTs into categories based on the findings from sections previous sections. Such a classification aspires better understanding of ICTs for their efficient implementation in the field of knowledge management in business organizations. Conclusion summarizes the research carried out.

ICT in business operation: In today's business life, workers interact daily with software applications for processing of data and information to carry out working

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tasks benefiting from the possibilities offered by the information and communication technology that performs automated processing through demanding computations and tedious actions. Working with text processors, spreadsheets, sending electronic mail, calling everywhere at any time through mobile phones and several other applications of ICTs became a substantial part in all spheres of our everyday life: at work in the school and at home. Companies rely on IT solutions to support their business operations by automated processing of data much faster than was possible before the development of digital information and communication technology. IT is not a mere enabler for business activity anymore (Cherbakov *et al*., 2005). ICT drives business strategy, open new markets and possibilities.

ICT gained wide application in the field of knowledge management. Several applications of ICT have gained considerable popularity as instruments for knowledge management (Hendriks, 1999). ICT gained interest based on its potential of using them to systematize, facilitate and expedite firm-wide knowledge management (Alavi and Leidner, 1999).

ICT can enhance knowledge sharing by lowering temporal and spatial barriers between knowledge workers, and improving access to information about knowledge (Hendriks, 2001). ICTs in connection with knowledge management are called organizational knowledge management systems (Meso and Smith, 2000) or knowledge management systems (Alavi and Leidner, 1999; Maier and Hadrich, 2011; Alavi and Leidner, 2001; Huysman and Wit, 2004). These are seen as enabling technologies for an effective and efficient knowledge management. The objective of knowledge management systems is to support construction, sharing and application of knowledge in organizations (Alavi and Leidner, 2001).

ICTs are used for knowledge management in form of infobase, knowledge base, mobile knowledge base, network, electronic rapports, knowledge mapping, Lotus Notes, digital discussion platforms (Huysman and Wit, 2004). Technology based perspective on knowledge management contains ICTs used in form of executive information systems, expert systems, intelligent agents, multimedia, search engines and smart systems (Alavi and Leidner, 2001), computer resident knowledge repositories (Huber, 2001), data mining, data warehouse, routines that are programmed in the logic of computational machinery and on data residing in data warehouses, use of email or group support systems, codification approach in which a central repository holds knowledge under categories such as programming bugs, quality control reports, new developments (Desouza, 2003), World Wide Web, Lotus Notes, the internet and intranets (Leary, 1998), Wiki (Raman *et al*., 2005).

Research in the field of knowledge creation based on data stored in databases and data warehouses through mining not only raised new questions of how to store and access data efficiently (Pavlo *et al*., 2009; Han *et al*., 2011; Reddy *et al*., 2010; Inmon, 2005; Taylor *et al*., 2015) but also created new perspective on the perception of knowledge, information and data connections that confirms Tuomi's insight declaring that knowledge is needed before data are collected and indeed, it determines which of these data to store (Tuomi, 1999). This becomes significantly important in industries were the data capturing is set like in software development industry this denotes the logging aspect (Chuvakin and Peterson, 2010; Suneetha and Krishnamoorthi, 2009; Marty, 2011). By deciding what to log, it can be seen that data emerges only after we have information and that information emerges only after we already have knowledge (Tuomi, 1999). In other words, only with sufficient knowledge the time of application development, it can be decided what data shall be logged to provide useful information for the bug investigation afterwards and that knowledge then becomes information (Alavi and Leidner, 2001).

MATERIALS AND METHODS

This classification is based on the following procedure. First, papers that associates ICT with knowledge management initiatives were identified with the help of "ICT knowledge management" as keywords in the ScienceDirect database which represented the primary source of investigated studies. The secondary database was represented by Google Scholar. Single technologies described in papers were identified. The endeavor not to include papers focusing on integration of ICT into an enterprise which represented the majority in the returned set of studies was the primary applied filter. Second, since, many paper related knowledge management with both data-warehouses and data mining, the next step was focused on search of paper associated with this technologies. Since, identified papers were mostly connected with technologies themselves and rarely associated with knowledge management initiatives, the Google Scholar database was used together with keywords "classification ICT knowledge management". Third, this was later extended by the keywords "knowledge management systems", since, many retrieved papers termed application of ICT in knowledge management as knowledge management systems. Fourth, keywords "data information knowledge definition" were used in Google Scholar. Fifth, real applications in practice were searched with the help of "application ICT knowledge management" as keywords. The main rationale was to avoid theoretical studies and to identify case studies. Last, keywords "application logging knowledge" were used. Although, many papers were out of scope (Nature Sciences, Physics or Ornithology), some valuable papers focused on knowledge management were identified.

RESULTS AND DISCUSSION

Classifications of ict in knowledge management: This section focuses on the classification of ICTs used knowledge management according to several classification categories divided into individual sections for the convenience of the reader.

Transfer of tacit and explicit knowledge: Organizational knowledge is generally classified into explicit knowledge and tacit knowledge (Lin *et al*., 2008). Where explicit knowledge denote knowledge that is more easily codified (Levin and Cross, 2004), it can relatively easily be formulated by means of symbols and can be digitalized. This knowledge can thus with relative ease be transferred to others by e.g., the use of information technology (Johannessen *et al*., 2001). On the other hand, tacit knowledge denotes now-how that is difficult to codify or explain (Levin and Cross, 2004), it is represented by skills (Johannessen *et al*., 2001; Foray and Lundvall, 1998). It is highly personal, context-specific and therefore, hard to formalize and communicate (Woo *et al*., 2004). It is also expressed by Polanyi (1997) by "we can know more than we can tell".

Based on the definition of tacit and explicit knowledge, it could be concluded that the knowledge transferred using ICT denotes only explicit knowledge and no tacit knowledge. This has been confirmed by research proving that tacit knowledge is mainly transferred by non-ICT methods with explicit knowledge being transferred via. a combination of methods (Nguyen and Burgess, 2014). However, it has been already concluded that tacit knowledge can be also transferred by video record (Nonaka and Krogh, 2009; Linde, 2001), video conferences, over the phone and by email (Smith, 2001). Considering these research findings, the ICTs could be classified into following categories: enabling transfer of explicit knowledge and allowing transfer of tacit knowledge.

Technological differences: Next classification of ICTs that can be found in the literature is the classification of ICTs used in knowledge management by dominating technology. The majority of knowledge management systems as can be concluded through analysis of above cited technologies used in organizational knowledge management systems and as already stated in review paper (Alavi and Leider, 1999), all of these used in organizations are based on following technologies: browser, electronic email, search/retrieval tools, information repositories, www server, agents/filters, external server services and videoconferencing.

Interaction and synchronicity aspects: The aspect analyzed in this section denotes the aspect of interaction. As it has been confirmed before by extensive research, learning by doing is the most memorable way of doing things in other words, we learn best by doing (DuFour *et al*., 2006). As resulted from research in the field of learning, there is only one effective way to teach someone how to do anything and that is to let him/her do it (Schank *et al*., 1999). The difference between memorizing explicit knowledge and the practical learning by doing become greater in the process of simulations as C. Aldrich stated: simulations may work in practice but they certainly do not work in theory (Aldrich, 2008).

The classification of this study includes the aspects of synchronicity and interaction. This classification aspects were chosen based on learning by doing aspect that denotes synchronous practicing and with needed interactive user participation. Further, the asynchronous mode allows incredible flexibility (Wheeler and Fournier, 2001), therefore, it is considered to denote a very important factor of ICTs in organizations. These two aspects could be put on axes to divide the plane into 4 quadrants. Technologies associated with particular quadrants are stated in Table 1. Considering these 2 aspects (4 categories), all the above mentioned ICTs can be assigned into.

As it can be seen, the prevalently used ICTs in the field of knowledge management denote passive, asynchronous technology that constitutes explicit knowledge. However, observing the organizational daily life, we can see more uses of ICTs than those mentioned in cited articles. It is important to mention, that people memorize more by watching and seeing than by reading (Aitken, 1994; Mattingly, 1972). And also singing a melodic song is easy to memorize and thus, easier and faster to learn than by reading (Dixon, 1991; Ludke *et al*.,

Table 1: Classification of mentioned ICT in specific quadrants

Quadrant	ICT focused on
Asynchronous, passive interaction	Info base, knowledge base, mobile knowledge base, network, electronic rapports, knowledge mapping, Lotus notes, expert systems, intelligent agents, computer resident knowledge repositories, data mining, data warehouse, routines that are programmed in the logic of computational machinery and on data residing in data warehouses, use of email or group support systems, codification approach in which a central repository holds knowledge under categories such as programming bugs, quality control reports, new developments, World Wide Web, Wiki
Asynchronous, active interaction	Internet, intranet, search engines, smart systems
Synchronous, active interaction	Digital discussion platforms
Synchronous, passive interaction	Multimedia (video record, sound record)

2014). Pictures are easier to recall than words (Paivio *et al*., 1968). Although, watching a clip is more than reading a text, people learn by repeating activities (Morris and Reid, 1970) and not only from one time action.

The second quadrant denotes the "Learning by doing" way. It lists the ICTs that require active interaction by the user, e.g., simulation-based software applications or modelling tools (Otcenaskova *et al*., 2011). They are creating the room for the end user to make questions, for the lector/leader to repeat actions and to transfer tacit knowledge on this way (DuFour *et al*., 2006; Aldrich, 2008; Wheeler and Fournier, 2001). Asynchronous but interactive courses allow to differently and efficiently divide time according to the time demands on the user side. The user can stop anytime and continue where he/she last broke up next time.

Asynchronous and passive knowledge bases are very often perceived to be tedious, boring as pure reading is very often being classified (Grauert and Remmert, 2012). Therefore, learning only by reading theoretical articles in particular in technical sciences containing several complex equations is very demanding and boring and thus transforms only explicit knowledge.

The higher the synchronicity the higher the possibility of transferring tacit knowledge and the higher the interaction demand, the higher the learning comprehended by the end user. Considering these aspects, the business organizations should try to use the ICTs with interactive approach whereas possible for both, synchronous (transferring also tacit knowledge) or for asynchronous mode (efficiently using time) to assure efficient knowledge transfer and management.

CONCLUSION

Several aspects of knowledge management such as its relationship with national culture (Brunet and Bures, 2013) has already been investigated. This study aims to add knowledge to the role of ICTs in the field of knowledge management by reviewing their role in various studies. Particular sections introduce complexity of knowledge management (Tucnik and Bures, 2013) an overview of ICT uses in the field of knowledge management while the last section provides various classifications of ICTs according to different criteria.

It opens a debate on appropriate usage of ICT in knowledge management. It emphasizes that knowledge is required before data gathering, otherwise it is complicated to promote data to information and consequently to knowledge. Moreover, the paper offers three classifications of ICT. Results from the first classification reveal that tacit knowledge are mostly transferred by multimedia. Results associated with the second classification shows that majority of technologies are based on the World Wide Web or databases. The third classification represents the novel point of view. While the first two classifications present various technologies, the third one focuses on synchronicity and interaction. It stressed that synchronicity positively influences independence and flexibility of work. On the other hand, it negatively affects time of work and causes delays. Interaction deals with increasing ability to learn by more intensive inclusion and activity. Thus, this aspect can significantly help with internalization of knowledge.

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