Online Journal of Applied Knowledge Management
A Publication of the International Institute for Applied Knowledge Management

Volume 3 Issue 2, 2015

The evaluation method of Web 2.0/3.0 usability in e-health knowledge management system

Anna Sołtysik-Piorunkiewicz, *University of Economics in Katowice, anna.soltysik-piorunkiewicz@ue.katowice.pl*

Abstract

This article aims to provide a method for evaluating the usability of Web 2.0/3.0 applications to support knowledge management in knowledge-based organizations which are at various stages of the knowledge management cycle, taking into account: generating knowledge, evaluating knowledge, sharing knowledge, etc., based on the example of an e-health knowledge management system. The method focuses on five areas of evaluation: GUI, functional structure, the way of content publication, organizational aspect, and technological aspect. The method is based on the proposed scoring in five areas of knowledge management system.

Keywords: information and communication technology (ICT), knowledge management system (KMS), Web 2.0/3.0 usability.

Introduction

The purpose of the paper was to present the knowledge management impact of modern information and communication technology (ICT) tools (interactive communication channels, agent oriented technologies, etc.) in the company due to developing of Web 2.0/3.0, e.g. social media, blogs, micro blogs, forums, wikis. The practical aim of the paper was to show the method of evaluation of a Web 2.0/3.0 ICT tool of in a knowledge management system (KMS). The paper is organized as follows: first the author presents a review on knowledge management systems, and then the author shows the development and evolution of the Web 2.0/3.application for managing the knowledge in context of e-health organization. The next section focuses on the evaluation research method of Web 2.0/3.0 usability in an e-health knowledge management system, where the author presents the criteria and measurements of an evaluation method. In the final section the author shows the results an evaluation using thefive criteria on an e-health knowledge management system, which are in different stages of the knowledge management cycle.

Modern knowledge-based organizations understand the importance of knowledge in the process of creating a competitive edge. According to the definition, a knowledge-based organization is an organization "whose structure is subordinated to and focused on creating value added based on an effective use of knowledge" (Grudzewski & Hejduk, 2004). Thus, IT solutions focused on the aspect of supporting such organizations should support business processes that take place in them in the area of creating, processing, and sharing a contextual knowledge about them (Zack, 2003). This results from the fact that knowledge-based organizations focus not only on business processes, but also on knowledge management processes with modern Web-based application support (Sołtysik-Piorunkiewicz & Zytniewski, 2013). The healthcare units as a knowledge-based organization must efficiently manage their knowledge to provide high quality services. Computer science utilization and new information and communication technologies give these opportunities (Sołtysik-Piorunkiewicz, 2013, 2014, 2015). Nowadays the main new research of ICT tools for the healthcare and e-health area is focused on Ambient Intelligent with Web-based technology

with methods of knowledge discovery (Salem & Katoua, 2012; Ziuziański, Furmankiewicz, & Sołtysik-Piorunkiewicz, 2014).

Knowledge management system

The concept of knowledge management (KM) was developed to discover tools and methodologies for managing knowledge, which was described as one of classical factors of production with land, labor, and capital by Drucker (1993). Knowledge management promotes an integrated approach to identifying, capturing, evaluating, retrieving, and sharing all of an enterprise's information assets. These assets may include databases, documents, policies, procedures, and previously uncaptured expertise and experience in individual workers (Turban, Leidner, McLean, & Wetherbe, 2006).

Knowledge management has been growing in importance and popularity as a research topic and business initiative since the mid 1990s. This is sufficient time for KM to grow into a discipline (Jennex, 2007; Saad, Grundstein, & Rosenthal-Sabroux, 2010). The information systems field has also expressed an interest in KM (Alavi & Leidner, 2001; Ruggles, 1997; Travica, 2013).

A knowledge management system (KMS) is dedicated to help an organization meet its goals and increase its effectiveness. The literature review shows that there are multiple definitions of knowledge management systems that have been proposed in the literature, and debates about this concept have been expressed from a variety of perspectives and positions (Wiig, 2000; Nonake & Takeuchi, 1995; Jennex 2009).

Nonake and Takeuchi (1995) consider KM to be the capability of an organization to create new knowledge, disseminate it throughout the organization, and embody it in product, services, and systems. Knowledge management is the planning, organizing, motivating, and controlling of the people/processes and systems in the organization to ensure that its knowledge-related assets are improved and effectively employed. Knowledge-related assets include knowledge in the form of printed documents such as patents and manuals, knowledge stored in electronic repositories such as a "best-practices" database, employees' knowledge about the best way to do their jobs, knowledge that is held by teams who have been working on focused problems, and knowledge that is embedded in the organization's products, processes, and relationships. The processes of KM involve knowledge acquisition, creation, refinement, storage, transfer, sharing, and utilization. The KM function in the organization operates these processes, develops methodologies and systems to support them, and motivates people to participate in them. The goals of KM are the leveraging and improvement of the organization's knowledge assets to effectuate better knowledge practices, improved organizational behaviors, better decisions and improved organizational performance.

Although individuals certainly can personally perform each of the KM processes, KM is largely an organizational activity that focuses on what managers can do to enable KM's goals to be achieved, how they can motivate individuals to participate in achieving those goals, and how they can create social processes that will facilitate KM success.

There are some models of lifecycle knowledge management in organizations. While the majority of the models refer to the first phase as knowledge creation, Davenport and Prusak (1998) use the term generates knowledge, whereas Van der Spek and Spijkervet (1997)

entitle this analogous phase knowledge development. In this paper, the author describes the method of evaluation of Web-based knowledge management systems in e-health using Turban's Knowledge Management Cycle (Turban, Leidner, McLean, & Wetherbe, 2006) which shows six steps of processes:

- Create knowledge: Creates knowledge through new ways of doing things
- Capture knowledge: Identifies and captures new knowledge
- Refine knowledge: Places knowledge into context so it is usable
- Store knowledge: Stores knowledge in repository
- Manage knowledge: Reviews for accuracy and relevance
- Disseminate knowledge: Makes knowledge available at all times to anyone

Therefore, in this article, the knowledge management cycle is defined as the process of knowledge generation (creation) (KG(C)), knowledge sharing (KS), knowledge dissemination (KD), knowledge organizing (managing) KO(M), and knowledge leverage (KL) in the context of e-health organization. A detailed definition of these processes will be presented when linking them with the different aspects of the Web-based application's functionality that supports an e-health knowledge management system.

The development of the Web application

The concept of Web application is the idea of building web services with the active participation of users and it is an integral concept of accompanying online marketing. Web development began with Web 1.0, which is the traditional World Wide Web. Its basic premise is the ability to publish information that can be read by the recipient using a web browser. This has created a wide field of opportunities for both developers and users, but it was medium sided and users could not perform any interaction. This feature was not a problem for commercial applications such as online transactions in e-commerce, e-commerce business models, and Internet portals. All of these applications have oriented data.

Development of the network began to evolve in the direction of the opening of the Internet to the recipient. The revolution in this area emerged from the Web 2.0 culture. This term was coined by O'Reilly (2004) for conferences on new web trends.

Web 2.0 has been called the architecture of participation. This idea became the basis for social networking, i.e. Web 2.0. The basis of Web 2.0 is to provide easy ways to publish information and the introduction of a social aspect. It was a completely new approach. The essential point is that the recipient is building a portal which creates, provides, and disseminates information (applications, components or whole parts of sites). In this approach, both the designers and users of services benefit from this opening up to the recipient. Developers can use the ideas of users. Websites may become more popular by the placing of external links within them. The most important value, however, is free and open access to knowledge.

The main tools of Web 2.0 are blogs, social networking sites, and wikis, which are communication tools that allow users to share content with each other and collaborate online. Web 2.0 features are commonly known as postulates, namely the ideas that describe the people-oriented approach. These include: participation, standards, decentralization, openness, modular approach, user control, and identity (O'Reilly, 2007).

All of these properties are the strength and importance of Web 2.0. The first postulate - participation - is the participation of users in creating and sharing content using platforms such as blogs, social networking sites, and wikis (O'Reilly, 2007). Web 2.0 is governed by certain standards, which are common, harmonized criteria for access to content. This enables the integration of many components available on the Web 2.0. Another feature is decentralization, which is a departure from the data stored on the servers as intermediaries in the exchange of knowledge for the dispersion and flexibility of use of the application architecture and content. Another postulate refers to the openness of the second generation of the Web. It means opening portals to the user by allowing them to transparently access the published applications and content, while limiting full control of the information posted there. Web 2.0 is characterized by a modular approach, that is the whole construction of several integrated modules thereby generating synergies. The advantage of this approach is that each Web 2.0 application can become part of the next. Additionally, the user is able to select elements which they want to use according to their needs. The next requirement is one of the most controversial, because it speaks of taking control over the content by the user who creates and retrieves the data, and decides which ones are worth highlighting. This is the expression for creators of Web 2.0 to give users the great opportunity for interaction and integration. The last feature of Web 2.0 is the user's identity, which is the identity used when the user creates content as a member of an online community (Brake, 2013).

The next generation of the Web is Web 3.0, which is no longer focused on the people, but on the machine. The first time this term was used by John Markoff in an article published in The New York Times in 2006 (Markoff, 2006, p. 1). The task of Web 3.0 is to facilitate the understanding of the machinery of the information contained in the online networks so information and content can be more intuitively and efficiently searched by the user. The idea of Web 3.0 requires not only data (like Web 1.0 and 2.0), but also the metadata, which is information about the data. It postulates transformation into a computer network database. This allows data binding on the Internet, taking into account the aspect of meaning, differentiating the data by the machine with the identical record, and also carried out on these data inference. This direction of development for the Web allows the use of modern technologies: the semantic web, artificial intelligence, and three-dimensional graphics. The idea of Web 3.0 requires the use of universal technologies that enable communication between the parties and web applications.

Although Web 3.0 has not yet been used on a mass scale, the vision already exists for the further development of the Web, and that is Web 4.0. Another idea that the development of the network will evolve towards creating a knowledge base, in which we will no longer search using keywords, but it will be agent-oriented. The vision of Web 4.0 as an intermediate layer, where the network will start its operations as an operating system or, as some like to define this, the smart grid.

Establishment of the Web was the reason for the creation of a new, shorter line of communication between the firm and the client, which could be a key role in building a relationship with him. However, the web client is perceived as more demanding and less loyal than traditional client. He expects novelty and convenience of purchase. This makes it more important to measure the quality of the recipient's experience of the product. This means that the Web client has different requirements than traditional client and there is a need for other action by the company, as part of marketing.

Today, outside banners have also used other advertising techniques, such as buttons (small ads placed usually in the vicinity of the side navigation menu), the pop-up (so-called pop-ups or new windows display advertising or separate websites), and video ads (very common, acting as banners, but display short videos instead of images or animations) are still used in newsletters, links, and appropriate positioning of websites in search engines.

Contextualization of e-health knowledge management system

The knowledge must be contextualized so that the shared knowledge can again be enhanced and measured. Contextualization links the learner, the expert knower, and the knowledge outcomes. Contextualization provides a suggested path for the application of the knowledge. Where the knowledge came from - the author, the subject of work, the time, and the location - and where the knowledge can be sent. In the final transport of knowledge, it is acquired and put to use by learners. After this application occurs, the learners may have new insights to increase the value of the knowledge. Some of the information can be tacit. Learners could recall that a machine worked better after further adjustments, or perhaps they combined the knowledge of several sales strategies with even more success than either strategy on its own. The information used in updating knowledge can also be explicit. For example, a presentation which suggests methods for improvement or a customer review of how the applied knowledge affected them is already codified. Each of these decision points - assessment, contextualization, and updating - use new information to validate and enhance, divest the existing knowledge, and create a more intelligent, more competitive organization.

There are the three main user groups of current Web applications in e-health system: consumers/patients, health professionals, and biomedical researchers. Each of these user groups have a different level of knowledge, but even end users like consumers/patients can be seen as experts according to the Web 2.0 philosophy and their collective wisdom can and should be harnessed (Eysenbach, 2008).

The ideal e-health Web application would actually try to connect different user groups and foster collaboration between them, e.g. engaging the public in the biomedical research process. There are some major aspects that emerge from Web 2.0/3.0 in health, health care, and medicine, which will outlive the specific tools and services offered. These emerging and recurring themes are Web applications and Web-based services for health care consumers, caregivers, patients, health professionals, and biomedical researchers, which use Web 2.0 technologies and/or semantic web and virtual-reality tools to enable and facilitate social networking, participation, apomediation, collaboration, and openness within and between user groups (Eysenbach, 2008). The e-health knowledge management system is connected with knowledge about the patient, contextual knowledge about the course of the conversation in e-health, knowledge of the presented medical problem, and knowledge of the e-health organization (Furmankiewicz, Sołtysik-Piorunkiewicz, & Ziuziański, 2014). An example of a Web-based application for e-health knowledge management is the "ZIP" system (acronym for "Zintegrowany Informator Pacjenta"). The screen shot of ZIP system was shown at Figure 1.

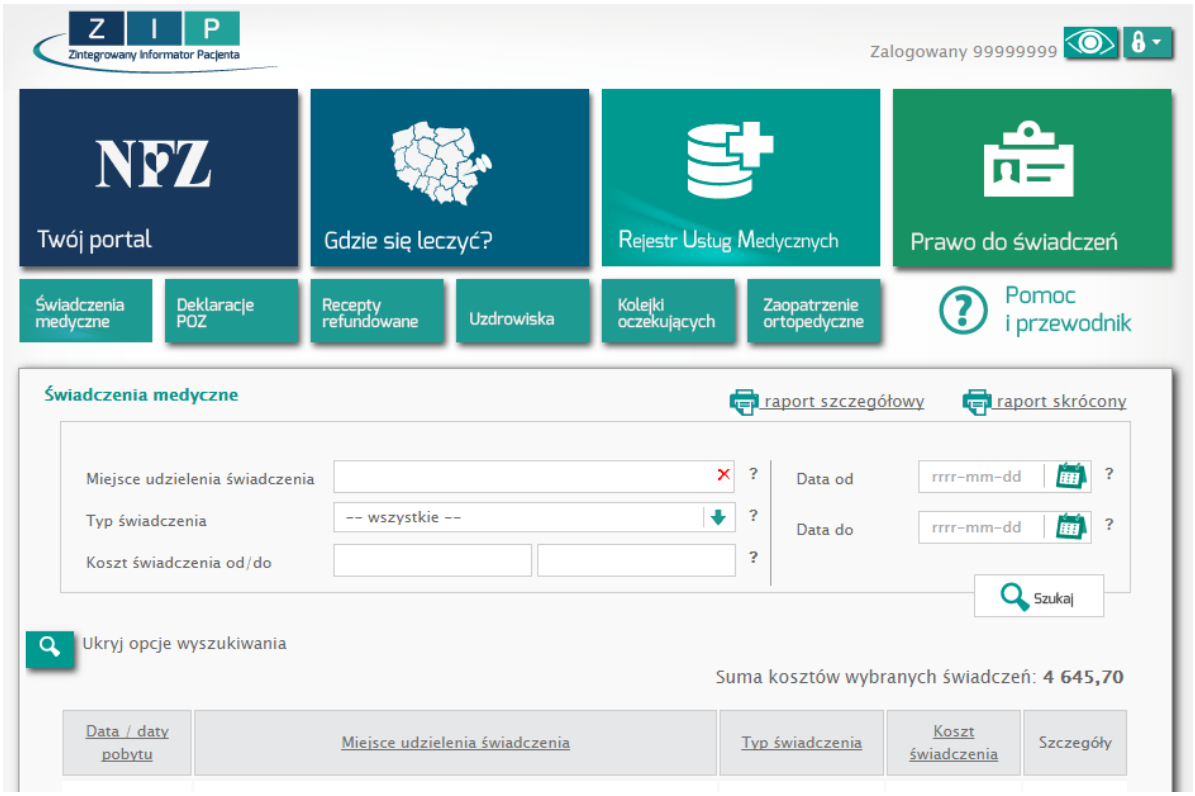

Fig.1. Example of Web-based application: e-health knowledge management in "ZIP" system (https://zip.nfz.gov.pl/ap-zipmed/user/med/med@default)

The evaluation research method of Web 2.0/3.0 usability in knowledge management system

The evaluation research method of Web 2.0/3.0 usability in knowledge management systems is based on some steps. The first step is to characterize criteria for the main features of Web-based application usability in knowledge management systems. The criteria was developed during a brainstorm session with a group of experts and compared with some well known evaluation checklists (Chmielarz, Szumski, & Zborowski, 2011; Ovaska, 1991; Ravden & Johnson, 1989). The described criteria were divided into five groups:

1. The graphical user interface (GUI) of Web-based application,
2. The functionality of Web-based application,
3. The way of content publication of Web-based application,
4. The organizational aspects of Web-based application,
5. The technological aspects of Web-based application.

The graphical user interface criterion (1) is divided into three sub-criteria: (1.1) Colors, (1.2) Graphics, (1.3) Matching elements. The functional structure (2) is based in five sub-criteria: (2.1) Subscriptions, (2.2) Search, (2.3) Archive, (2.4) Comments, and (2.5) Connection with company web sites. The way of content publication criterion (3) in divided into two sub-criteria: (3.1) Multimedia elements and (3.2) Text elements (comments). The organizational aspects of evaluation (4) of usability are based on SEO (4.1) Marketing techniques used, (4.2) Advertising, and (4.3) Communication. Technological aspects (5) of usability evaluation of

Web-based application are: (5.1) Effectiveness, (5.2) Performance, (5.3) Satisfaction. Each criterion should be scored for each area of a knowledge management system (KMS): knowledge generation (creation) (KG(C)), knowledge sharing (KS), knowledge dissemination (KD), knowledge organizing (managing) KO(M), and knowledge leverage (KL).

The measurement proposals of each criterion were discussed in the next phase of the research and grouped in five areas of a KMS:

1. The graphical interface:

For colors:

1. Amount of colors
2. Clearness of colors
3. Maintaining in the company graphics
4. Simplicity of colors
5. Matching of the colors

For graphics:

1. Amount of graphics
2. Clearness of graphics
3. Maintaining in the company
4. Simplicity of graphics
5. Matching the graphics

For matching elements:

1. Amount of matching elements
2. Clearness of matching elements
3. Maintaining in the company graphics
4. Simplicity of matching elements
5. Kind of matching elements

2. The functional structure

For subscriptions:

1. Availability of subscription
2. Amount of subscriptions
3. Frequently of subscriptions
4. Amount of subscriptions
5. Amount of guidance and support tool

For searching:

1. Availability of searching
2. Amount of proper findings
3. Frequently of proper findings
4. Amount of searching tool
5. Amount of human searching tool

For archiving:

1. Availability of archiving
2. Amount of archival knowledge
3. Sorting by timeliness
4. Frequently of archiving by web-based software
5. Frequency of archiving by human expert

For comments:

1. Availability of putting the comments
2. Amount of comments

3. Amount of human moderation
4. Amount of web-based software moderation
5. Error prevention and correction of web-based software

For connection with organization web sites:

1. Availability of connection with web sites
2. Amount of connections with web sites
3. Amount of connections with main web page
4. Amount of connections with customer (patient) web page
5. Amount of connections with supplier web page

3. The way of content publication

For multimedia elements:

1. Amount of multimedia categories (Videos, Photos, Avatars, etc.)
2. Amount of multimedia
3. Appropriate amount of multimedia elements
4. Form of multimedia elements
5. Kind of multimedia elements

For response to comments:

1. Amount of authors' comments
2. Amount of human experts' comments
3. Frequency of response to authors
4. Frequency of response of software
5. Frequency of response of human experts

4. Organizational aspects

For SEO marketing techniques used:

1. Availability
2. Amount of SEO marketing techniques
3. Amount of SEO software marketing techniques
4. Amount of SEO human experts
5. Positioning of entry at SEO

For advertising techniques used:

1. Amount of advertising for social networks
2. Amount of advertising for employees
3. Amount of advertising for customer
4. Amount of advertising for supplier
5. Amount of advertising (in connection with the own company)

For communication techniques used:

1. Amount /frequency/ time/ of Inter- Communication tools
2. Amount/frequency/time/ of Intra-Communication tools
3. Amount of software tools/frequency/time/ of dialogue between the customers
4. Amount of SCM tools
5. Amount of CRM tools

5. Technological aspects

For effectiveness:

1. Percentage of achieved goals
2. The percentage of the task realization
3. The average accuracy of completed tasks
4. Readability / clarity of the knowledge - has the knowledge of the user been increased
5. Number of the system outputs understood as the number of channels used by Web-based software to Communicate / availability for the user

For performance:

1. The time needed to complete the task/Web-based software's reaction time
2. The number of tasks completed per unit of time
3. The level of satisfying the informational needs/Knowledge complexity/
4. Correctness of knowledge/Knowledge complementary/ Mean time between failures
5. Web based software's time of response

For satisfaction:

1. The height of global satisfaction ratings
2. The incidence of voluntary use
3. The frequency of complaints
4. Simplicity / readability of the interface /Attractiveness of the user interface
5. Understanding level of the user interface language/clarity of communication

Every criterion is judged and given a point score, which is subject to verification and clarification by means of appropriate indicators of a given feature. The evaluation study is based on points using the Chmielarz et al.(2011) method of evaluation. The points scale ranges from 0 to 4 for each subcriteria:

- 0 point- none
- 1 points - acceptable
- 2 points - week
- 3 points - good
- 4 points - very good

Each criterion should be scored in each area of the KMS: knowledge generation (creation), knowledge sharing, knowledge dissemination, knowledge organizing (managing), and knowledge leverage.

Table 1 shows the template of points, the summarization of each criteria, and the total summarization for the example of an e-health knowledge management system in the "ZIP" case study. It shows the way to use the evaluation method for each criteria and the total summarization.

The discover evaluation method of Web 2.0/3.0 usability can answer the following questions:

1. What is the impact of graphical user interface of a Web 2.0/3.0 application on knowledge generation/creation knowledge sharing, knowledge dissemination, knowledge organizing, and knowledge leverage in an e-health KMS?
2. What is the impact of the functional structure of a Web 2.0/3.0 application on knowledge generation/creation knowledge sharing, knowledge dissemination, knowledge organizing, and knowledge leverage in an e-health KMS?
3. What is the impact of the way of content is published in a Web 2.0/3.0 application on knowledge generation/creation knowledge sharing, knowledge dissemination, knowledge organizing, and knowledge leverage in an e-health KMS?
4. What is the impact of the organizational aspects of a Web 2.0/3.0 application on knowledge generation/creation knowledge sharing, knowledge dissemination, knowledge organizing, and knowledge leverage in an e-health KMS?
5. What is the impact of the technological aspects of a Web 2.0/3.0 application on knowledge generation/creation knowledge sharing, knowledge dissemination, knowledge organizing, and knowledge leverage in an e-health KMS?

Table 1. The template of summarization of points for each evaluation criteria (own research)

Points	**e-health knowledge management system**						
	generation/ creation (G/C)	sharing (S)	dissemination (D)	organizing / managing (O/M)	leverage (L)	**Sum of points in area of KMS**	**% of Total points of criterion**
Evaluation criteria of Web-based system							
1. The graphical interface							
1.1. Colors	1	2	3	3	4	**13**	**65%**
1.2. Graphics	3	3	3	3	1	**13**	**65%**
1.3. Matching elements	4	4	3	3	2	**16**	**80%**
Sum of GUI points	8	9	9	9	7	42	**70%**
% of Total GUI point	67%	75%	75%	75%	58%		
2. Functional structure							
2.1. Subscriptions	0	3	1	3	1	8	40%
2.2. Search	2	1	2	1	3	9	45%
2.3. Archive	1	3	1	4	1	10	50%
2.4. Comments	1	1	3	0	1	6	30%
2.5. Connection with company web sites	0	2	0	0	0	2	10%
Sum of functionality points	**4**	**10**	**7**	**8**	**6**	**35**	**58%**
% of Total functionality point	**20%**	**50%**	**35%**	**40%**	**30%**		
3. The way of content publication							
3.1. Multimedia elements	0	0	0	0	0	0	0%
3.2. Response to comments	0	0	0	0	0	0	0%
Sum of usability points	**0**	**0**	**0**	**0**	**0**	**0**	0%
% of Total organizational aspects point	**0%**	**0%**	**0%**	**0%**	**0%**		
4. Organizational aspects							

Points	**e-health knowledge management system**						
	generation/ creation (G/C)	sharing (S)	dissemination (D)	organizing / managing (O/M)	leverage (L)	**Sum of points in area of KMS**	**% of Total points of criterion**
4.1. SEO marketing techniques used	3	0	1	2	2	8	40%
4.2. Advertising techniques used	1	0	1	1	1	4	20%
4.3. Communication techniques used	3	1	1	3	1	9	45%
Sum of points of organizational aspects	**7**	**1**	**3**	**6**	**4**	**21**	35%
% of Total technological aspects point	**58%**	**8%**	**25%**	**50%**	**33%**		
5. Technological aspects							
5.1. Effectiveness	3	3	3	3	3	15	75%
5.2 Performance	3	3	2	2	2	12	60%
5.3 Satisfaction	2	2	2	1	1	8	40%
Sum of points of technological aspects	**8**	**8**	**7**	**6**	**6**	**35**	**58%**
% of Total functionality point	**67%**	**67%**	**58%**	**50%**	**50%**		
Total sum of points	**27**	**28**	**26**	**29**	**23**	**133**	
% of Total points	**42%**	**44%**	**41%**	**45%**	**36%**	**42%**	

Conclusions and the future research

The discover evaluation method of Web 2.0/3.0 usability can answer the question of how Web 2.0/3.0 applications can influence the knowledge generation/creation, knowledge sharing, knowledge dissemination, knowledge organizing, and knowledge leverage in an e-health KMS. Every criterion could have the propriety measurements of quantity and percentage amount of the chosen factor, clearness of the chosen factor, maintaining in the company of the chosen factor, simplicity of the chosen factor, matching of the chosen factor, frequency of the chosen factor, availability of chosen factor, etc.

The future research will be considered in measurements of the impact of Web application usability on knowledge management in a health care knowledge-based organization at three levels of management, operational, tactical and strategic, and building the model of e-health KMS.

References

Brake, D. R. (2013). *Are We All Online Content Creators Now? Web 2.0 and Digital Divides*. Journal of Computer-Mediated Communication, Retrieved January 3, 2015 from http://onlinelibrary.wiley.com/doi/10.1111/jcc4.12042/pdf.

Chmielarz, W., Szumski, O., & Zborowski, M. (2011). *Kompleksowe metody ewaluacji jakości serwisów internetowych*, Warszawa: Wydawnictwo Naukowe Wydziału Zarządzania Uniwersytetu Warszawskiego.

Cross, M. S. & Sivaloganathan, S. S. (2007). *Specialist knowledge identification, classification, and usage in company-specific new product development processes*. Proceedings of the Institution of Mechanical Engineers -- Part B -- Engineering Manufacture (Professional Engineering Publishing).

Dalkir, K. (2005). *Knowledge management in theory and practice*. New York: Elsevier Butterworth-Heinemann.

Davenport, T. & Prusak L. (1998). *Working knowledge how organizations manage what they know*. Boston: Harvard Business School Press.

Drucker, P. (1993). *Post-capitalist society*. New York: Harper Business.

Evans, A. A. & McKinley, M. M. (2010). *Paradigm and paradox: Knowledge management and business ethics*. Proceedings of World Academy of Science: Engineering & Technology.

Eysenbach, G. (2008): Medicine 2.0: Social Networking, Collaboration, Participation, Apomediation, and Openness. *J Med Internet Res* , *10*(3), 22

Furmankiewicz, M., Sołtysik-Piorunkiewicz, A., & Ziuziański, P. (2014): *Artificial intelligence systems for knowledge management in e-health: the study of intelligent software agents*. [w:] Latest trends on Systems: 18th International Conference on Systems: Santorini Island, Greece.

Gołuchowski, J. (Ed.) (2011). *Wprowadzenie do inżynierii wiedzy*. Warszawa: Difin.

Grudzewski, W.M., & Hejduk, I.K. (2004). *Zarządzanie wiedzą w przedsiębiorstwach*. Warszawa: Difin.

Jelenic, D. (2011). *The Importance of Knowledge Management in Organizations – with emphasis on the balanced scorecard learning and growth perspective*. Retrieved January 3, 2015 from http://www.issbs.si/press/ISBN/978-961-92486-3-8/papers/ML11-1.pdf.

Jennex, M.E. (2009). *Knowledge Management: Concepts, Methodologies, Tools and Applications*. Hershey, PA, USA: IGI Publishing.

Jennex, M.E. (2007). *Knowledge Management In Modern Organizations*. IGI, London. Retrieved January 3, 2015 from http://www.amazon.com/Knowledge-Management-Modern-Organizations-Advances/dp/1599042614

Markoff, J. (2006). Entrepreneurs see a web guided by common sense, *The New York Times*.

Nonaka, I. & Takeuchi, H. (1995). *Knowledge-Creating Company: How Japanese companies create the dynamics of innovation*. New York: Oxford University Press.

O'Reilly, T. (2007). What Is Web 2.0: Design Patterns and Business Models for the Next Generation of Software. *Communications & Strategies65*, 17. Retrieved January 3, 2015 from http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1008839.

Ovaska, S. (1991). Usability as a goal for the design of computer systems. *Scandinavian Journal of Information Systems, 3*, 47-62.

Ravden, S. & Johnson, G. (1989). *Evaluating Usability of Human-Computer Interfaces: A Practical Method*. Chichester: Ellis Horwood.

Ruggles, R. (1997). *Knowledge management tools*. Oxford: Butterworth-Heinemann.

Saad, I., Grundstein, M., & Rosenthal-Sabroux, C. (2010). Challenges in capitalizing Knowledge in innovative product design process. *Journal of Systemics, Cybernetics & Informatics, 8*(4).

Salem, A. M. & Katoua, H. S. (2012). Web-Based Ontology of Knowledge Engineering. *Journal of Communication and Computer*, 1336- 1342.

Sołtysik-Piorunkiewicz, A. (2013). The development of mobile Internet technology and ubiquitous communication in a knowledge-based organization. *Journal of Applied Knowledge Managemen*t, *1*, 29-41.

Sołtysik-Piorunkiewicz, A. (2014). *Technologie mobilne w zarządzaniu organizacją opartą na wiedzy*. In R. Knosala (Ed.) Innowacje w zarządzaniu i inżynierii produkcji, Opole: PTZP.

Sołtysik-Piorunkiewicz, A. (2015). *Web technology in mobile organization management.* In R. Knosala (Ed.) Innowacje w zarządzaniu i inżynierii produkcji, Opole: PTZP.

Sołtysik-Piorunkiewicz, A. & Żytniewski, M. (2013). *Software Agent Societies for Process Management in Knowledge-Based Organization*, 14th European Conference on Knowledge Management, ACPI, pp. 661-669.

Travica, B. (2013). Conceptualizing knowledge culture. *Journal of Applied Knowledge Management, 1*(2), 85-99.

Turban, E., Leidner, D., McLean, E., & Wetherbe, M. (2006). *Knowledge management*, [in:] Information technology for management: transforming organisation in the digital economy. New Jersey: John Wiley, pp. 365-405.

Van der Spek, R. & Spijkervet, A. (1997). *Knowledge Management: Dealing intelligently with knowledge*. In J. Liebowitz, & L. Wilcox (Eds.), Knowledge management and its intergrative elements. New York: CRC Press.

Wiig, K.M. (1993). *Knowledge management foundations*. Arlington: Schema Press.

Xu, Y. & Bernard, A. (2011). Quantifying the value of knowledge within the context of product development. *Knowledge-Based Systems, 24*(1).

Zack, M. H. (2003). Rethinking the Knowledge-Based Organization. *Sloan Management Review, 44*(4), 67-71.

Ziuziański, P., Furmankiewicz, M., & Sołtysik-Piorunkiewicz, A. (2014). E-health artificial intelligence system implementation: Case study of knowledge management dashboard of epidemiological data in Poland. International Journal of Biology and Biomedical Engineering, 8.