THE REVIEW OF MOBILE SYSTEMS FOR HEALTHCARE KNOWLEDGE MANAGEMENT

Anna SOŁTYSIK-PIORUNKIEWICZ

Summary: The article presents the concept of e-health with usage some mobile technology in applications' examples. The classification of mobile application for healthcare knowledge management was based on some past reviews. The review of mobile systems was also based on literature research conducted in December 2016. The aim of the article is to show different functionalities of mobile technologies in e-health systems. The next chapter after introduction shows the developing of concept of usage ICT in healthcare as e-health. The third chapter shows the different aspect of healthcare knowledge management. The forth chapter shows overview of mobile technology functionalities in m-health knowledge management systems. The conclusions and topic of future research in area of mobile systems for healthcare knowledge management was also shown at last.

Keywords: mobile technology, mobile health, knowledge management, ICT

1. Introduction

E-health is the information system of all activities within the healthcare using information and communication technologies (ICT). In addition to the technological aspect in the definition of e-health attention is also drawn to the humanistic aspect. G. Eysenbach [1] provides in its definition, that technological changes in knowledge management in e-health affect change in the global approach to improve health care on a local, regional and global level. E-health can include a range of services provided in health care facilities, hospitals, and clinics, in terms of streamlining processes for patient, doctors and government health care units. The e-health is divided into subsystems knowledge management dedicated to consumers (patients, society) and for health professionals (medical staff, managers). Sub-system elements include measures for the health care system, e.g., the patient record management, telemedicine, knowledge management, health protection, etc. This article presents the concept of e-health with usage some mobile technology in applications' examples. The review methodology was based on literature research conducted in December 2016.

2. The concept of usage ICT in healthcare:e-health

The concept of e-health involves the use of information and communication technologies in healthcare. In the current political and demographic role of modern technologies in e-health appears to be a key factor in the improvement of the existing state of the health care system. Thanks to the applied solutions government agencies in Europe and in the world of e-health are becoming more and more dynamically developing new branch of industry. This can improve access to health care and improving the quality and efficiency of the services offered in the health care sector. E-health involves the use of ICT in all the functions and activities that are carried out in the knowledge management in the

health sector, and also includes e-health tools and solutions (products, systems and services) that go beyond simple Internet applications. These are tools, both for management to knowledge management in the health sector (health managers) as well as health professionals, and personalized health systems for patients and citizens. Examples of ICT for knowledge management in e-health are among mobile systems, mobile devices, health information networks, electronic health records, telemedicine services, health portals, and many other solutions based on the technologies supporting the prevention, diagnosis, treatment, monitoring and health management lifestyle. When combined with organizational changes and the development of new skills in the information society, e-health can help to provide better care with less financial resources within health systems citizen. The use of ICT in knowledge management in e-health is a response to the key challenges posed in front of managers the health sector by the European Union. E-Health is today a tool to significantly increase the efficiency of knowledge management for health, while ensuring adequate instruments restructuring of health systems, while respecting the confidentiality of data and information using the security and interoperability of systems.

There are a number of tools used in the area of e-health, one of the purposes of seeking information and learning about health. There are the specify, among others, Web 2.0 tools such as weblogs, forums or discussion groups, specialized medical portals or news on health, Internet encyclopedias, Internet expert systems, video online consultation with doctors, physicians, medical advice online, compare the prices of drugs, online pharmacies. The development of information systems based on solutions of Web 2.0 has opened up new possibilities for improving the management of medical knowledge and became the basis for building a model system Health 2.0 and the concept of assessing the usefulness of these systems from the point of view of the user [1, 2].

The tools in the area of e-health are also a public, private and government websites related to the topic of health care. Apart from the earlier tools, we can replace thus: the information pages of government (e.g., The Ministry of Health) [3], public (e.g., Website specific SPZOZ) and private (e.g., website selected NZOZ) units of health care, preventive information pages, government management systems, medical services, e.g., ZIP, eWUŚ [4, 5]. In addition to the information systems of knowledge management of medical services [6], they are also used medical systems, e-business B2C or B2B (e.g., e-shops, auction websites). These are different user groups and stakeholders of health systems in Poland using ICT tools, e.g., patients, medical staff, care providers, SPZOZ-s, medical practices, pharmacies, and also state authorities responsible for the distribution of financial resources from the state budget for medical services [7] (e.g., The National Health Fund), the bodies control and surveillance (e.g., the State Sanitary Inspection), Ministry of Health (Sołtysik-Piorunkiewicz, Furmankiewicz, Ziuziański, 2015b). The past research allowed identifying four areas of e-health ICT tools functionality. These areas are [8, 9]: communication, e-commerce, diagnosis, and knowledge management.

3. Knowledge management in e-health systems

Managing of the huge amounts of health information that must be available to safely gain access to them at the right time, as well as efficient processing of information necessary for administrative purposes it is necessary to ensure the best health care in the context of limited budgetary conditions. Knowledge management in e-health focused mainly on ensuring the use of appropriate modern technologies in the field of software and building systems. Systems and services in e-health, combined with organizational changes

and the development of new skills in the information society are key tools for improving efficiency and productivity in the health sector. They can form the basis for improving the quality of services in the medical sector and increase the availability of these services. Both the authorities and health managers are responsible for the proper organization and management of health systems. This is accomplished against the background of increasing budgetary pressure, and similar expectations of patients. E-health systems can play an important role in knowledge management in the health sector. The right decisions in the field of public health and clinical health can be undertaken only on the basis of comprehensive, high quality administrative and clinical data. The authorities of the EU Member States involved in the management of health could benefit from better access to more comparable data on health. There is a huge demand for this type of data, for example, in the fight against infectious diseases. Integrated and comprehensive data can be made available in a timely manner with the use of e-health tools, such as electronic health records system and web in support of the management processes of care. Automatic data extraction from electronic health systems that operate in accordance with the legal requirements in Europe could provide missing data that will facilitate a proper assessment of available resources and eliminate the huge administrative burden of filling specific forms. Thanks to the systems and e-health services, it is possible to carry out the modernization of the healthcare system. Increased mobility of patients and health professionals in the development of the internal market requires the integration of clinical, organizational and economic covering all health care institutions in order to facilitate the availability of services through the creation of the virtual enterprise (or mobile enterprise). E-health systems can support managers by spreading best practices and helping to reduce or eliminate the inefficient and inadequate services. This is one of the basic effects of knowledge management in e-health for the stock and ensures broad access to quality care for all. In addition, e-health opens new opportunities for residents in areas with limited accessibility to health care, as well as marginalized groups (such as people with varying degrees of disability, minors, the elderly, etc.). Implementation of e-Health in Europe and in developing countries have shown already that they can provide a platform for telemedicine services such as tele-consultations (second medical opinion), tele-monitoring and tele-care at home or in hospital.

4. Overview of mobile ICT tools in healthcare knowledge management systems

Modern mobile technologies enable the continuous evolution of the information society towards becoming easier access to information in the form of affordable and interactive application as mobile health (e.g., mobile ewuś, mobile ekuz). In the face of increasing popularity of mobile Internet and mobile users' attention focused all kinds of applications on these devices for healthcare knowledge managment. According to the Central Statistical Office in 2014 approximately 35.8% of people aged 16-74 were using mobile devices to connect to the Internet outside the home or outside the workplace. Respondents often used with mobile phones or smartphones (26.8%) than with portable computers or laptops, tablets (23.4%). It is also worth mentioning that the availability of the Internet in Poland from year to year increases. In 2014 the percentage of households with broadband Internet access stood at 71.1%. On the other hand, in the case of mobile devices they play an important role so hotspots, which allow users to connect to the Internet, usually through a wireless network based on a standard Wi-Fi. According to the Office of Electronic Communications number of local hotspots installed in public places in Poland amounted to

2 227 in 2014. This number was more than 200 higher than in 2013. It is worth quoting the results of the report "Digital, Social and Mobile in 2015" in January 2015. According to the report, globally 33% of websites have their mobile views, in Poland this percentage is higher and amounts to 46%.

The time they spend Poles in the Internet is 4.9 hours, and mobile Internet use on average 1.8 hours a day (the average in the world, respectively 4.4 and 2.7 hours).

In Poland, the lives of 25.7 million active Internet users, are acting in 67% of the Polish population. There are as many as 15.9 million active mobile Internet users in Poland, 41% of all Poles [4, 5, 6]. Nowadays there are a lot of different mobile applications for healthcare knowledge management.

Mobile health (mHealth) describes the use of portable electronic devices with software applications to provide health services and manage patient information. Mobile health (mHealth), as defined by the World Health Organization (WHO), is an area of electronic health (eHealth) that provides health services and information via mobile technologies such as mobile phones and PDAs. mHealth can also support the performance of health care workers by the dissemination of clinical updates, learning materials, and reminders, particularly in underserved rural locations in low- and middle-income countries where community health workers deliver ICCM to children sick with diarrhea, pneumonia, and malaria. Various numbers of themes have been used previously within the mHealth system, and finally 6 areas was presented in a report by Vital Wave Consulting [10] (table 1). That report shows the key mHealth technologies included mobile phones, PDAs and smartphones, patient monitoring devices, and mobile telemedicine devices.

Another research [11, 12, 13, 14, 15, 16, 17, 18] was considered also how mHealth may support patient monitoring, clinical decision making, and tracking of drugs, supplies, and emergencies with different way of communication (table 2).

The researches article of Pew Research Center's Internet & American Life Project [19] shows some mobile applications, whose main task is to improve the quality of life of the user in the context of a healthy lifestyle at various levels. Exercise, diet, and weight apps are the most popular types of health apps downloaded. Some 38% of health app users track their exercise, 31% monitor their diet, and 12% use an app to manage their weight. Other health apps track menstrual cycles, blood pressure, pregnancy, blood sugar or diabetes, and medication. The WebMD app was also cited, along with a number of other brand-name apps. A full list of uncategorized responses is below:

- "About how the human body works".
- "Hearing".
- "Health insurance app".
- "Personal business app".
- "Brain trainer".
- "Allergy alert, weather channel pollen alert".
- "MD encyclopedia".
- "Hypnosis".
- "Medical handbook".
- "An app for medicines, doctors, and hospitals in the area".
- "Drugs".
- "Kids' illnesses".
- "Walgreens" (as "Walgreens", and as "Walgreen app for prescriptions").
- "Stop smoking".

Tab. 1. The areas and themes of mHealth system

No.	Area of mHealth	Description
1.	Education and awareness	Primarily 1-way communication programs to mobile subscribers via SMS/text messaging in support of public health, behavior-change campaigns.
2.	Data access	Applications designed to use mobile phones, PDAs, or laptops to enter and access patient data. Some projects may also be used by patients to access their own records.
3.	Monitoring and compliance	One- or 2-way communications to the patient to monitor health conditions, maintain caregiver appointments, or ensure strict medication regimen adherence. Some applications may also include inpatient and outpatient monitoring sensors for monitoring of multiple conditions (such as diabetes, vital signs, or cardiac).
4.	Disease and emergency tracking	Applications using mobile devices to send and receive data of disease incidence, outbreaks, geographic spread of public health emergencies, often in association with Global Positioning System (GPS) systems and backend applications for visualization.
5.	Health information systems	Applications developed for "back office" or central health care information technology systems allowing for access by and integration with mHealth application. Such applications often tie-in to regional, national, or global systems.
6.	Diagnosis and consultation	Applications developed to provide support for diagnostic and treatment activities of remote caregivers through Internet access to medical information databases or to medical staff.

Source: Report by Vital Wave Consulting, after [10]

Tab. 2. Example of mHealth applications utilizing different way of communication

No.	Communication Type	Example of mHealth Application tools
1.	1-way	SMS/rapid SMS
2.		Sending data
3.		Push messages
4.		"Please call me" message
5.	2-way	Sending data and receiving feedback
6.		Quizzes/games
7.		Hotlines/textlines
8.		Remote consultation/training
9.	Multiway	Frontline SMS
10		Facebook
11.		Twitter

Source: [10]

- "Search app about my health".
- "P tracker women's health app".

– “Pharmacy doctor benefits”.
– “Asthma”.
– “Triage”.
– “Headaches”.
– “Anatomy”.
– “First aid”.
– “Heart disease”.
– “Medical diagnosis app”.
– “Insurance tracker”.
– “App for monitoring fluids for kidney stones”.
– “Blood work”.
– “Comparing prescriptions”.
– “App for symptoms”.
– “Drug guide and diagnosis”.

Additionally the research literature review was conducted in December 2016. The research methodology was based on searching in Web of Science in terms of: “mobile technology”, “mobile health”, “ICT”, “IoT”, “information society”, “mobile organization”, “Health 2.0”, “Web 2.0”, and “management”. As a result of searching Web of Science Search Alert the table 3 is shown the amount of publication about “mobile technology & mobile health” and “mobile technology & management”. Other searching topics had 0 results.

Tab. 3. The result of publication searching in Web of Science: Search Alerts in Dec. 2016

Search Alert / Category	1/12/2016	8/12/2016	15/12/2016	22/12/2016	29/12/2016	No. of publication
Mobile technology & mobile health	21	29	13	28	27	118
Mobile technology & management	2	5	4	2	4	17
No. of publication	23	34	17	30	31	135

Compare to the anther classification, the mobile application shows the different functionalities for healthcare knowledge management in context of:

– "Physical activity".
– "Diagnostics".
– "Pharmacotherapy".
– "Communication".
– "Motivation".
– "Addictions and habits".
– "Healthy".
– "Relaxation and meditation".
– "Entertainment".
– "Helping" [20].

"Physical activity" is a category of applications supporting sports and providing various kinds of sets of exercises to maintain and support fitness and health [20].

The group "Diagnostics" can include applications to diagnose health problems, e.g., regarding eyesight, and hearing. To this category may also include expert systems, whose task is to identify the disease based on the symptoms that the user chooses. These applications allow for consultation cases in the medical world. Applications in the "Pharmacotherapy" support the use of drugs through reminders. This group may include applications also support for diabetics taking insulin.

In the "Health information" are applications that provide, among others, information on the functioning of health services, vaccination or information about specific disease entities [21, 22, 23].

In turn, the group "Communication" has been assigned to applications that allow users to share their results on social networks and those that allow you to create communities of users of the application. Application Group "Motivation" contains the applications that support the use of gamefication element of the user in achieving the objectives, particularly for the achievement of the desired weight or figure through proper exercise and diet. Such applications often act as a personal adviser healthy lifestyle or personal trainer. Applications in the "Addictions and habits" are designed to strengthen good habits of users of these applications or help in reducing addictions. "Healthy" is a group of applications that support the user in obtaining information relating to food intake, in particular it contains nutrients. In this group there are also applications that support calorie counting and applications that provide sample menus. Another group of applications is extracted as "Relaxation and meditation". It is quite a broad group that accommodates applications on relaxation (including e.g., the game, as well as applications that allow you to listen to the sounds of nature), healthy sleep (to help sleep / stand up or sleep monitoring) and meditation. In addition, this group includes applications to support coping with stress and difficult situations. Applications in the "Entertainment" are in a game, which can operate and relaxing anti-stress. In addition, there can also be classified applications that combine pro-health and educational character with elements of fun. Group "Helping" includes applications that allow medical emergencies and provide briefing on first aid to the victim.

5. Conclussion and future research

Nowadays there are the various numbers of themes used within the mHealth system, and finally 6 areas were presented in a report by Vital Wave Consulting (table 1). That report shows the key mHealth technologies included mobile phones, PDAs and smartphones, patient monitoring devices, and mobile telemedicine devices. The ways how these tools can be used for education and awareness, data access, and for strengthening health information systems will be explored also in the future research. The result of searching Web of Science Search Alert in the table 3 showed the amount of publication about “mobile technology & mobile health” and “mobile technology & management”. There is a lack of publication in area of “mobile technology”, “mobile health”, “ICT”, “IoT”, “information society”, “mobile organization”, “Health 2.0”, “Web 2.0”, and “management”. There is a lot of classification of mobile application in e-health knowledge management. Some of them were described in this paper. The point of view of different way of classification is focused on patient, caregiver, and user of application (or e.g., way of communication (table 2)). The main area of mobile application in health care knowledge management is the healthier life, diseases diagnostics, medical education, helping people with different health difficulties, e.g., motivation to healthy life, exercises, stop with drugs or smoking, and also some mental or other diseases. As indicated, the mobile devices are

entering in different areas of modern knowledge management, including the sphere of health. It is justified therefore, we need to examine the use of mobile devices in this area.

Literatura

1. Eysenbach G.: Medicine 2.0: Social Networking, Collaboration, Participation, Apomediation, and Openness. J Med Internet Res, 10(3), 2008, p. 22.
2. Sołtysik-Piorunkiewicz A.: Implementation of IT system in health protection. [in:] R. Knosala (Ed.) Innowacje w zarządzaniu i inżynierii produkcji, PTZP, Opole 2013, pp. 568-576.
3. Sołtysik-Piorunkiewicz A.: The Recent Ideas and Trends in Health Care Information Systems in Poland, [in:] J. Palonka, M. Pańkowska (Ed.): Ambient technology and Creativity Support Systems Volume: 188, Studia Ekonomiczne/Uniwersytet Ekonomiczny w Katowicach, Katowice 2014, pp. 218-225.
4. Sołtysik-Piorunkiewicz A.: The management of patient information in Polish health care system, International Journal "Information Theories and Applications", Vol. 21, Number 2, 2014, pp. 182-194.
5. Korczak K.: Internetowe narzędzia wspomagające opiekę zdrowotną. Wydawnictwo Wolters Kluwer SA, Warszawa 2014, pp. 67-79.
6. Sołtysik-Piorunkiewicz A.: The evaluation method of Web 2.0/3.0 usability in e-health knowledge management system [in:] Online Journal of Applied Knowledge Management, A Publication of the International Institute for Applied Knowledge Management, Volume3, Issue 2, 2015, pp. 168-180.
7. Sołtysik-Piorunkiewicz A., Furmankiewicz M., Ziuziański P.: Rola portali informacyjnych w kontekście wyszukiwania informacji i pozyskiwania wiedzy w e-zdrowiu. [in:] Studia Ekonomiczne, Zeszyty Naukowe Uniwersytetu Ekonomicznego w Katowicach, Informatyka i Ekonometria, 2015 (1), Nr 216/2015, Wydawnictwo Uniwersytetu Ekonomicznego w Katowicach, Katowice 2015, pp. 94-105.
8. Sołtysik-Piorunkiewicz A., Furmankiewicz M., Ziuziański P.: Kokpit menedżerski jako narzędzie do wspomagania decyzji prosumenta w e-zdrowiu. [in:] M. Pańkowska (Ed.) Uwarunkowania technologiczno-społeczne i modele prosumpcji systemów informatycznych zarządzania. Wydawnictwo Uniwersytetu Ekonomicznego w Katowicach, Katowice 2015, pp. 188-212.
9. Sołtysik-Piorunkiewicz A., Furmankiewicz M., Ziuziański P.: Spersonalizowany kokpit menedżerski jako przykład podejścia kontekstowego w zarządzaniu wiedzą. [in:] Studia Ekonomiczne, Zeszyty Naukowe Uniwersytetu Ekonomicznego w Katowicach, Informatyka i Ekonometria, 2015 (1), Nr 216/2015, Wydawnictwo Uniwersytetu Ekonomicznego w Katowicach, Katowice 2015, pp. 106-117.
10. Källander K., Tibenderana J.K., Akpogheneta O.J., Strachan D.L., Hill Z., ten Asbroek A.H.A., Conteh L., Kirkwood B.R., Meek S.R.: Mobile Health (mHealth) Approaches and Lessons for Increased Performance and Retention of Community Health Workers in Low- and Middle-Income Countries: A Review, J Med Internet Res 2013;15(1).
11. Sołtysik-Piorunkiewicz A.: Web technology in mobile organization management. [in:] R. Knosala (Ed.) Innowacje w zarządzaniu i inżynierii produkcji, PTZP, Opole 2015, pp. 819-830.
12. Sołtysik-Piorunkiewicz A.: Knowledge management impact of information technology Web 2.0/3.0. The case study of agent software technology usability in knowledge

management system, AIP Conference Proceedings, Volume 1644, Issue 1, 2015, pp. 219-227.
13. Sołtysik-Piorunkiewicz A.: The evaluation method of Web 2.0/3.0 usability in e-health knowledge management system [in:] Online Journal of Applied Knowledge Management, A Publication of the International Institute for Applied Knowledge Management, Volume3, Issue 2, 2015, pp. 168-180.
14. Sołtysik-Piorunkiewicz A., Furmankiewicz M., Ziuziański P.: Wykorzystanie technologii ICT w społeczeństwie informacyjnym w świetle badań systemów zarządzania wiedzą w e-zdrowiu, [in:] A. Białas (red.): Informatyka w Województwie Śląskim – innowacyjne trendy rozwoju, Instytut Technik Innowacyjnych EMAG, Katowice 2015, pp. 33-44.
15. Sołtysik-Piorunkiewicz A., Furmankiewicz M., Ziuziański P.: Badanie: Internet i zdrowie. Ogólnopolski System Ochrony Zdrowia, OSOZ Nr 9/2015, Kamsoft SA.
16. Sołtysik-Piorunkiewicz A., Furmankiewicz M., Ziuziański P.: Czynniki determinujące zachowanie internautów w obszarze e-zdrowia na podstawie wyników badań z lat 2013-2015. [in:] T. Porębska-Miąc (Ed.) Systemy Wspomagania Decyzji SWO 2015, Wydawnictwo Uniwersytetu Ekonomicznego w Katowicach, Katowice 2015, pp. 61 - 78.
17. Sołtysik-Piorunkiewicz A., Furmankiewicz M., Ziuziański P.: Web healthcare applications in Poland: trends, standards, barriers and possibilities of implementation and usage of e-health systems. [in:] I. Deliyannis, P. Kostagiolas, Ch. Banou (Ed.), Experimental Multimedia Systems for Interactivity and Strategic Innovation, IGI 2016, pp. 258-283.
18. Sołtysik-Piorunkiewicz A.: Organization of healthcare entity: the study of hospital information system. [in:] R. Knosala (Ed.) Innowacje w zarządzaniu i inżynierii produkcji, PTZP, Opole 2016, pp. 141 -147.
19. Fox S., Duggan M.: Mobile Health 2012, Pew Research Center's Internet & American Life Project, Washington, 2012.
20. Sołtysik-Piorunkiewicz A., Furmankiewicz M., Ziuziański P.: Systemy mobilne w e-zdrowiu, [in:] Informatyka i przemysły kreatywne, „Studia Ekonomiczne", (Ed.) J. Gołuchowski, Uniwersytet Ekonomiczny w Katowicach, Katowice 2017.
21. McGee-Lennon M., Bouamrane M.M., Grieve E., O'Donnell C.A., O'Connor S., Agbakoba, R., Devlin A.M., Barry S., Bikker A., Finch T., Mair F.S.: mHealth Interventions to Counter Noncommunicable Diseases in Developing Countries Still an Uncertain Promise, Cardiology Clinics, 35 (1): 2017.
22. Lee E., Han S., Jo S.H.: Consumer choice of on-demand mHealth app services: Context and contents values using structural equation modeling, International Journal Of Medical Informatics, 97, pp. 229-238; 2017.
23. Ganasegeran K., Renganathan P., Rashid A., Al-Dubai S.A.R.: The m-Health revolution: Exploring perceived benefits of WhatsApp use in clinical practice, International Journal Of Medical Informatics, 97, pp. 145-151; 2017.

Anna SOŁTYSIK-PIORUNKIEWICZ, Ph.D.
Department of Informatics
University of Economics in Katowice
1 Maja 50, 40-287 Katowice
tel./fax: (0-48) 32257-7274
e-mail: apiorunkiewicz@ue.katowice.pl