KNOWLEDGE BROKERS FOR E-HEALTHCARE PROSUMPTION

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Abstract: Creation of radical innovation is a real challenge, which requires unconventional thinking of the physician and patient, as well as a huge staff of people involved in healthcare process. It is an extremely important, but complex and costly activity, not only because of its telemedicine infrastructure, but also because of rising public expectations for healthcare, as well as social requirements to reduce chronic diseases, and to eliminate cancer. The paper is to emphasize the role of knowledge brokers in e-healthcare. The first part covers presentation of arguments for e-healthcare prosumption as a way to reduce cost in the context of Good Information Society. The second part includes discussion on e-healthcare system architecture conceptualization. The last part is to justify the knowledge brokering development for e-healthcare prosumption.

Key words: e-healthcare, prosumption, system architecture, ArchiMate modelling, knowledge brokers

1. e-Healthcare prosumption

Information communication technology (ICT) is influencing the health services. The initiatives are ranging from the telemedicine infrastructure to websites which promote health services and health call centres responsible for medical advices and implementation of electronic patient records [Adams & McCrindle, 2008]. People are encouraged to call and discuss their problems with online advisors rather then immediately visiting their local doctor. This independent approach to gaining medical information is also fuelled by individuals becoming less attached to the science of medicine.

Websites provide individuals with opportunities to find support groups and to join in discussions supported by online experts about various health problems. However, potentially detrimental health issues could arise when either accurate information is used improperly or when inaccurate information is taken as correct and used as such. Recent advances in ICT have enabled a vast range of self-diagnosis tests to be available on the Internet, which also support the distribution of self-testing kits, i.e., pregnancy test kits, blood pressure monitors and ovulation tests. However, an increasing variety and number of these tests is becoming available on the market, including those for serious diseases such as prostate cancer, osteoporosis, HIV, Hepatitis C, Anthrax, and colon cancer. Medical tests are divided in the following overlapping categories: screening tests to detect a probable disease, diagnostic tests to determine if a person has a particular disease, monitoring tests, predictive tests to assess whether a person is at risk of developing a disease. Access to that kits provides many benefits, i.e., reducing the waiting times to see the doctor, the convenience of carrying out the test in their own home, avoiding the embarrassment of approaching a doctor, saving costs by not visiting the doctor in person.

Internet pharmacies are prosperous, but some remedies may cause side effects when taken with other drugs. Frequently offered drugs such as Ritalin, Viagra, Prozac, and Xenical should only be taken with medical advice due to possible side effects. There is also

the quality problem, as some of the drugs contain safe but ineffectual substances while others are highly reactant and dangerous substances. Beyond that, social media and open source ICT tools create for Internet users the opportunities to share their experiences and services concerning different diseases.

In an open communication model, users are seeking personalised expertise and practices that are derived from relationship rather than healthcare services. In Internet like on a bazaar, users innovate for themselves because they want something that is not available on the service market, either because the professional services are too expensive, or just because of the pleasure to act anonymously. Therefore, the key problem in managing open information distribution consists of providing coordination of activities, and users' willingness to cooperate.

The prosumption is not a particularly new phenomenon. For years, it was a production for own usage by producer. So, in economics, it was considered as a marginal activity, concerning mostly agriculture. However, because of work dividing, task sharing and specialization, the producers have provided goods and services to the market and they develop series and mass production. Although the ability to produce large quantities of products has improved and later, low proficiency of mass production encouraged producers to introduce customized product development. The prosumption can be considered as a next step in market products' development. Consumers create information exchange environment based on their innovativeness and value creation models where collaboration predominates.

In cyberspace, there has been a huge debate about the direction in which societies of the future should go. According to Duff, to be against strategy of openness and open information distribution means to be against the socio-economic development and the growth of the world society [6]. However, Duff promotes the Good Information Society, which covers active citizens, respecting privacy protection, and honesty in management and legal regulations concerning Internet content. Duff argues that information politics or information governance principles should be established within liberal philosophy, creating background for development of crucial ideas of liberty, equality and solidarity. Information society should not be a result of free market activities nor technology determinism. According to Duff, social structure covering information governance must be regulated by social democracy leaders [7].

2. System architecture modelling for e-healthcare prosumption

An architecture of a system is fundamentally concerned with organization of its constituent elements and relationships among that elements to achieve a given purpose [22].

ISO/IEC 42010 is an international standard that provides a conceptual framework for incorporating architectural thinking into the development of a system [12]. Every system exhibits an architecture that addresses the concerns and constraints of its stakeholders and its environment. Constraints are decisions that have been made to limit the freedom a system architect has with respect to those decisions. Conceptual model of an architecture framework is included in ISO/IEC 19501 standard [12]. A system architecture models are developed to:

- improve understanding and methods of organization working, by abstracting the complexity of the overall organization and by careful studying internal organizational activities,

- allow all the members of an organization to review the business based on a common picture,
- design and implement the business processes,
- change the organizational structures and to better align the ICT with relevant business activities,
- gain the complete view of the business organization,
- increase the efficiency of business process reengineering [2].

The main aim of the modelling exercise is to go beyond the concrete description and to fetch the abstract view of a modelled object. Business system modelling is to describe business objectives, activities, information resources, processes, actors, products, requirements, and the relationships between those activities. Although the system architecture development is expected to convey semantic unification, nowadays the business modelling approaches do not offer mutually agreed languages. Companies have to customize and adapt recognized architecture framework to meet their requirements, so perhaps they have no opportunities to reduce costs, efforts, and work time.

The system architecture is analysed as a process as well as a product [21]. As a product, the architecture serves to guide managers in designing business processes and it supports system developers in building applications in a way that is in line with business objectives and policies. The effects of the architecture as a process cover information flow and activities to achieve business objectives.

The system architecture development is supported by a structured collection of methods and techniques. Methods usually specify the various phases of architecture's life cycle, what deliverables should be produced at each stage, and how they are verified. In literature, the methods for the system architecture development, i.e., the Zachman Framework (ZF), the Federal Enterprise Architecture Framework (FEAF), the Command, Control, Computers, Communication (C4), Intelligence, Surveillance, and Reconnaissance (C4ISR Architecture Framework), the Treasury Enterprise Architecture Framework (TEAF), The Ministry of Defense Architectural Framework (MODAF), the Computer Integrated Manufacturing Open System Architecture (CIMOSA), the Dynamic Architecture (DYA), and The Open Group Architecture Framework (TOGAF) are evaluated as the most frequently used and constantly improved [11, 16, 18, 19].

Generally, the TOGAF architecture framework has two meanings:
- a formal description of a system, or a detailed plan of the system at component level to guide its implementation,
- the structure of components, their inter-relationships and the principles and guidelines governing their design and evolution over time [20].

There are four architecture domains:
- the business architecture that defines the business strategy, governance, organization and key business processes,
- the data architecture that describes the structure of an organization's logical and physical data assets and data management resources,
- the application architecture that provides a scheme of the individual applications, their interactions and their relations to the core business processes,
- the technology architecture that describes the logical software and hardware capabilities that are required to support the deployment of business, data, and applications services [20].

TOGAF is based on the US Department of Defense Technical Architecture Framework for Information Management (TAFIM) and as the open standard is divided into seven parts, i.e., Introduction, Architecture Development Method (ADM), ADM Guidelines and Techniques, Architecture Content Framework for architectural artefacts, Enterprise Continuum and Tools, TOGAF Reference Model, and Architecture Capability Framework [20].

The Architecture Development Method (ADM) is the core method for a system architecture transformation within TOGAF. The method defines eight sequential phases and two other special phases, i.e., A. Vision, B. Business architecture, C. Information system architecture, D. Technology architecture, E. Opportunities and solutions, F. Migration planning, G. Implementation governance, and H. Architecture change management [4]. According to TOGAF, a model is a representation of a particular subject. The model provides this representation on a reduced scale, in a simplified or more abstract manner depending on the subject in question. In the context of enterprise architecture, the subject is the enterprise or some of its parts.

Some of the views of a system architecture are illustrated by the diagrams. A diagram as a graphical view is not to present the entire model, but rather to generally explain it. The main function of enterprise architecture modelling tools is to provide graphical editors that support TOGAF models and guarantee the correct use of TOGAF concepts. The Modelio modelling tools provide useful features to support TOGAF modelling [15]. ArchiMate is another modelling tool published by the Open Group [3]. ArchiMate is now linked to the evolution of TOGAF.

3. Model of user participation in e-healthcare prosumption process

Although, the user centred design process focuses on computer end user tasks, as well as on understanding the user's cognitive, behavioural and attitudinal characteristics, there is a lack of procedures, which strictly depict the role of user in the information system exploitation process. Generally, the user experience methodologies allow for gaining a very comprehensive understanding of user experiences within information systems as well as domain knowledge. However, for information system customised development, not only user experience is important, but also user creativity and opportunities to implement their creative ideas in the business environment. The framework for end user involvement is a system development and exploitation should be supported by system architecture modelling. The proposed in this paper, e-healthcare prosumption support system model is based on the idea of prosument-patron relationship (PPR) development and management. In this approach a patron is understood as human (library custodian, knowledge broker) or computerized agent, which supports users in the process of exploitation of the knowledge based e-healthcare information system. The knowledge broker also ought to be engaged in IT system and e-healthcare services development as well as in user learning processes (see Figure 1).

In many developed countries citizens have access to e-healthcare information systems. In Poland, the governmental systems of e-healthcare cover systems, i.e., ZIP, eWUŚ, EKUZ. However, beyond that the prosument-patron relationship systems development seems to be necessary to support e-healthcare prosumption, in order to support self-diagnosis, self-testing, self-monitoring and even self-treatment in case of disease. The patron is to be responsible for gathering user requests and providing the competent

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knowledge to them. Generally, the patron receives three types of information from prosuments, i.e., patients, their family members or care takers:

- information about incentives, diseases. These problems MUST BE solved and professional knowledge advice is required,
- questions, which answers are delivered by the patron or end user with the help of patrons. The answers COULD BE received, otherwise the user further browses the Internet to find the solution,
- suggestions provided by users as the result of their own experiences and practices. Suggestions SHOULD BE further surveyed, carefully analysed and presented in the form of case studies.

The knowledge brokers have access to the following sources of knowledge:

- scientific libraries including articles from scientific journals, articles from professional research reports, books or book chapters, repositories of peer-reviewed electronic articles, i.e., ProQuest, Sciencedirect, Cochrane, Medline,
- secondary documents. i.e., documents from websites, minutes from seminars and symposia, documents from other online knowledge brokers, government reports, and reports from international organizations, e.g., World Health Organization, OECD.
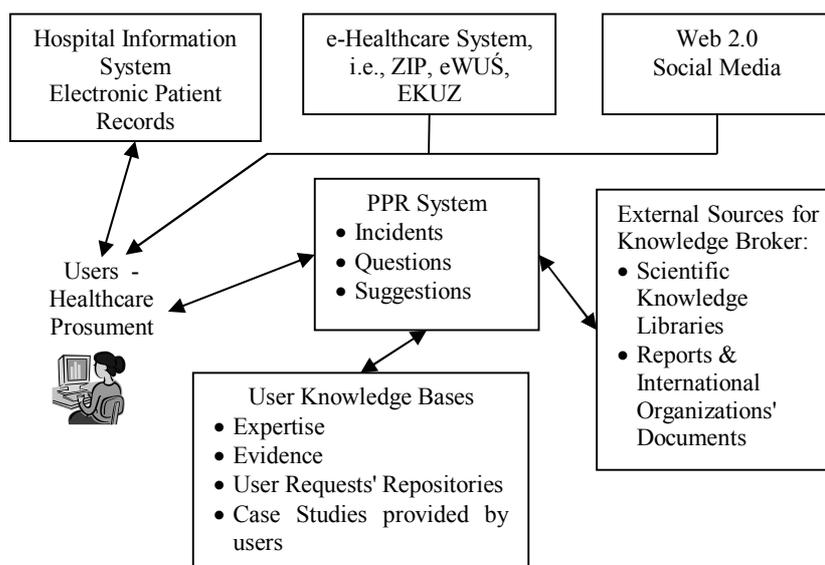

Figure 1. Proposed Framework of Prosument Patron Relationship (PPR) Model

The proposed framework (Fig.1) and architecture model (Fig.2) allow for the development of a system which is characterised by widening boundaries, a multiparadigmatic profiling, and methodological innovativeness. The approach allows to utilize user's experience, practices and perceptions.

The knowledge-based PPR system development relies not only on system developer research aims and epistemological stance, but also on organizational, historical, cultural, evidential and personal factors, which are not problems to be solved, but factors that must be included in practical research design. The approach should also include the context and

healthcare creativity of users. A system architecture model in ArchMate is organized into some basic layers:

- BUSINESS containing elements such as actors e.g. Patient, roles e.g. Prosument, Broker, processes e.g. e-Health Consultation Process, services e.g. Browsing, Conceptualization etc.
- APPLICATION covering elements such as Financial Application, Portal, Management System, Risk Evaluation, IT Support, etc.
- TECHNOLOYGY including elements such as Data Server, Application Server,
- MOTIVATION containing elements: drivers e.g. Consultation Need, principles e.g. e-Healthcare Knowledge Development Principles, assessments e.g. Consultation Evaluation, goals e.g. Patient Satisfaction, requirements e.g. Healthcare Requests (Figure 2).

When designing services within e-healthcare system, appropriate knowledge components should be assigned to them. According to Karlovcec et al. [13], a knowledge component is a description of a mental structure or process that is used alone or in combination with other knowledge components, to accomplish steps in a task or to solve a problem. Glassey [10] defined:

- declarative knowledge components representing domain knowledge (facts, events etc.) in terms of concepts and relations,
- procedural knowledge components describing actions to be taken in order to solve a problem. Actions can be undertaken individually or by collective.

According to Wilson [24] e-healthcare is a field of research and practice, covering medical informatics, public health and business, referring to health services and information in Internet, but it is also a state-of-mind, a way of thinking, an attitude, and a commitment for networked global thinking. That approach aims to emphasize preventive care and self-care by empowering patient with accurate and reliable knowledge.

User-oriented e-healthcare applications include websites, char sessions, newsgroups, e-mail exchanges with medical experts, wireless and digital broadcasts, and other compilations of online resources. Developing such a self-care system requires close cooperation between IT and clinical staff [17]. Self-care brings many benefits, i.e., ongoing costs and waiting time reduction, early avoidance of problems by self-diagnosis, networking of cancer survivors peer interaction, reaching more widely geographically dispersed groups. However, the tailoring of the website content requires heavy involvement of medical experts. There is also the risk of losing contact with people who might be vulnerable but will not ask for help as well as the need to legally regulate the roles of knowledge brokers and access to knowledge bases by users [17].

A knowledge broker (i.e., a patron) is to ensure a mutual understanding of goals and cultures, while collaborating with users to identify issues and problems for which solutions are requested. Knowledge brokers should facilitate the identification, access, assessment, interpretation, and translation of medical research evidence into local policy and practice. They ought to assist users in translating medical evidence into locally relevant recommendations for self-practice. They develop a trusting and positive relationship with end users, while at the same time they are promoting exchange of knowledge [5].

Dr Gunther Eysenbach introduced a concept of apomediation that is different from disintermediation i.e., transfer of relevant information from professionals to a patient [25]. The difference between an intermediary and an apomediary is that an intermediary stands in between the patient and information service, but in contrast, apomediation means that there are agents, people who stand by to guide a consumer to high quality information service

Figure 2. e-Healthcare Prosumption Architecture Model

and experience, without being a prerequisite to obtain that information service in the first place.

According to Lamari and Ziam [14] the origin of the concept of knowledge broker is based on three key paradigms dealing with knowledge and its influence on human behaviour. The first paradigm is knowledge management. It is considered as a unique production and serving the best practices and adequate funds to reinforce knowledge acquisition, assimilation, and translation into business processes, therefore the knowledge broker enables an organization to mobilize, manage and disseminate knowledge in a structured way to meet socio-economic challenges, i.e., performance, profitability, innovation, sustainability. The second paradigm concerns the social knowledge networks. The knowledge broker is responsible for mobilizing all the stakeholders interested in the knowledge production and dissemination. The knowledge broker is a community leader shaping the organizational culture. The third paradigm deals with capacity building through knowledge and know-how. Knowledge broker is to facilitate the social development through education, dissemination and explanation of useful knowledge in simple terms. Wilde [23] classifies knowledge in the way useful for e-healthcare prosumption development. He differentiates knowledge about the patient, knowledge from the patient and knowledge for the patient. Knowledge about the patient is gathered from care takers as well as in self-diagnosis process, and covers knowledge regarding mental and physical health status, behaviour, habits and demands. It is the result of analyses, interviews and observations. Knowledge from the patient is collected in a direct way. The patients informs knowledge brokers about their experiences with drugs, services, test, processes or their expectations. Consequently, the knowledge broker should take active part in the patient's knowledge gathering process. Knowledge for the patient means that they should be supported with "knowledge for the patient" in order to be accurately involved in self-monitoring and self-care process. The relevance of the knowledge to be disseminated is the biggest challenge for brokers, who should take into account the patient preferences and criteria for recognizing the value of knowledge. The recognition is based on the e-healthcare knowledge relevance (responding to the needs of potential users, and on its applicability to the reality) [14].

4. Conclusions

The development of e-healthcare prosumption is still a challenge. Although since the beginning of human life the first medical diagnosis was the auto-diagnosis (or diagnosis done by the nearest family) and the first therapy is usually auto-therapy. The presented in academic studies and in real life healthcare practices emphasize the passive role of the patient. They are oriented towards prevention and support rehabilitation. However, the high cost of medical treatment and open access to Internet enable to look for new ways of the development of the medical auto-diagnosis, self-monitoring, self-testing and going further - self-care. Nowadays, almost all diseases are described online, and virtual communities are developed to support patient and their relatives. There is a strong necessity to support the initiative of the Good Information Society, where knowledge brokers will be highly appreciated and their consultation services will be available online.

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