THE IMPACT OF SOCIAL MEDIA NETWORKS ON HEALTHCARE PROCESS KNOWLEDGE MANAGEMENT (USING OF SEMANTIC WEB PLATFORMS)

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Abstract: The emergence of social media networks in healthcare domain is nowadays comprehensively contributed for the knowledge acquisition and to support various activities in different tasks in healthcare processes. This study emphasizes the usage of social media networks and its impacts on healthcare stakeholders; patient, health practitioners, ICT and define their perspectives. The proposed framework for Social Media supported knowledge management System (SMKMS) incorporates domain knowledge acquisition e.g. healthcare process (Cardiac) and integrates with social media channels e.g. Facebook as inputs for the construction of domain ontology which can be considered as foundation for the development of health information system (HIS)in healthcare business.

Keywords: Social media, Knowledge management, Information system, Ontology, OWL, SPARQL, Jena API .

1. INTRODUCTION

The influence of social media networks (SMN) have been acknowledged in recent years due to its vibrant contributions in almost every field of life especially healthcare sector [1]. Nowadays, the frequent usage of social websites invites the consumers to share information in secure manner by using some social networking applications such as Facebook, Myspace, and Twitter. Current usage of social media networks [2] [3]. also entertains the consumer by using different gaming sites and virtual worlds such as Club Penguin, Second Life, and the Sims [1. Social media networks play vibrant role for information learning through video sites such as YouTube. The main advantages of these social media networks are to facilitate the consumers and domain users in terms of socialization and for reliable communication among domain users, enhanced learning opportunities among domain users, accessing the information and advertisement [1].

From both theoretical and technological perspectives, social computing technologies are moved beyond social information processing towards emphasizing social intelligence [4]. The transformation of social informatics to social intelligence is achieved by conceptual modeling [5] and analyzing social behavior [6] by capturing human social dynamics as well as by generating and managing actionable social knowledge (machine understandable) [4] which is useful in the development of information system (IS).

The inclusion of social media technologies is significant which helps to healthcare stakeholders; patients, administrators (managers) and practitioners in terms of independent knowledge learning, efficient information access and easiness in communication within healthcare processes. It also highlights two research issues; first what is the role of social media networks and how to facilitate and incorporate patient's preferences, awareness, learning and interaction with healthcare practitioners and patient-to-patient for quality treatment. Similarly, the Web 2.0 is also considered a way to improve intra and inter communication between healthcare professionals in healthcare organizations that helps to practitioners for shared improved decision making in any panic situation of healthcare process. Second, how semantic web platforms support knowledge management (KM) practices which help for sharing, collaboration and improved information flow within healthcare processes?

The influence of information processing technologies (IPT) [7] and some open innovations in various healthcare organizations is striving to maintain social media synergy in knowledge management system (KMS). These technologies can be helpful to facilitate improved internal and external information sharing, collaboration and communication among different individuals and for information flow within healthcare organizations. The main contribution of this paper is to propose formal method (ontology-based approach) which helps to visualize social networks inclusion with domain knowledge (contextual knowledge) and provides foundations for developing health information systems (HIS) which supports human social dynamics.

This paper is structured as follows. Section 2 briefly explains the importance of social media networks (SMN) and knowledge management (KM), the context of Web 2.0 and Web 3.0, integrated example of social media [8] and healthcare process [9]. Section 3 describes case study which illustrates the scenario of healthcare unit in Ryhov hospital1, Jönköping, Sweden. Section 4 explains in detail about methodology; ontological engineering approach and a practical framework of social media with KM. Section 5 shows experiments and results. Section 6 describes discussion and limitation of the study in following sections.

2. LITERATURE REVIEW AND CONCEPTUAL BASIS

This section highlights about the importance of social media networks (SMN) and knowledge management (KM) and context of Web 2.0, Web 3.0 and inclusion of

social networks in healthcare domain.

2.1 Social Media Networks (SMN) and Knowledge Management (KM)

The concept of social media are internet-based applications [10] designed to follow through with foundational basis of web 2.0 technology, encompassing exchange of information generated by users for the benefits of other users [2]. The salient features of social networks is to overcome geographical barriers, sharing information and collaborative in nature and improved shared decision making in critical stage of patient treatment process [2][8]. The inclusion of social media networks strongly intimates knowledge practices in various areas of healthcare delivery performance with respect to ; 1) knowledge elicitation, acquisition, and sharing, 2) knowledge application for clinical decision support, 3) capturing and sharing patient information [11]. Social media networks also support health knowledge management activities; knowledge creation and usage, knowledge preparation and diffusion and knowledge preservation and maintenance in health information system [12].

2.2 The Inclusion of Social Media in Health Care

Health informatics is one of the solutions to tackle traditional problems such as patient health records (PHR) etc. into electronic form for achieving quality health care outcomes in healthcare organizations [8]. Various social media applications can be used to achieve aforementioned goals in patient treatment process such as Facebook, blogs, wikis, videoconferencing, multimedia blogging and wide-ranging variety of social networking websites [13] which are grounded with web 2.0. The philosophy of web 2.0 is based on sharing information, collaboration, integration and effective communication among clinicians, practitioners and medical administrators [2][8].

2.3 Context of Web 2.0 in Healthcare

The concept of web 2.0 gives the projection of revolutionary web-based tools which allow user groups; medical administrator, clinicians and medical students to be used in a collaborative ways [14]. The usage of various web 2.0 applications [2] opened up new ways of delivering healthcare [8]. The promising aspects of social media networks are information sharing, integration, collaboration and user centricity in healthcare domain for service delivery that is more personalized to fulfill needs of individuals [8]. Similarly, web 2.0 technologies are used to overcome geographical barriers to the healthcare delivery in healthcare organizations especially Telemedicine [15] and Medicine 2.0 [16] the term of medicine 2.0 explains integration of medicine and web 2.0 applications and adding some values such as sharing, collaboration, openness and user-centricity. These added values help to facilitate in communication between all parties involved in the healthcare process which includes patient, clinicians, researchers and multidisciplinary healthcare

professionals [16]. The significant contribution of social media networks in collaborative healthcare is to promote innovative working pattern among clinical practitioners, patients and their families can work together [17].

2.4 Web 3.0 as a Knowledge Management and Representation Mechanism

The web 3.0 technology (semantic web platforms) is the extension of web 2.0 technologies which provides systematic mechanism of transformation of tacit knowledge into machine-readable form which is used for the development of Information systems (IS). Web 3.0 facilitates user groups in web 2.0 supported environments in the form of social networking, participation, apomediation, openness and collaboration within organizations and between users groups [16][17]. The role of semantic web platforms such as Ontologies is to offer a surprisingly fruitful way to analyze how social formations organize, change and grow in healthcare knowledge management process [17]. By focusing on social media networks, semantic web platforms help to analyze the structure of social formations and effects in the form of innovation, change, performance and operational failures in healthcare unit [17].

3. CASE STUDY

The case study is the amalgam of social media example [18] and healthcare process [9]. Some work described in this paper was partly carried out within the project "Bridging the Gaps" which is sponsored by The Jönköping Academy2 for Improvement of Health and Welfare. This case study illustrates the integration of social media with healthcare process (cardiac) and defines the mechanism how social media technologies can be helpful in patient treatment process in any medical unit. Different multidisciplinary healthcare professionals with different competences, roles and skills gather at the appointed time to assess the patient's status, collect information for making diagnosis, perform certain activities by using certain healthcare resources such as electronic medical record system (Cambio Cosmic), patient-admittance status system (EBBA) and laboratory database to fulfills certain tasks for achieving defined goals and as well as plan the patient's treatment process (see figure 1) [14]. The ward-round [9] in medical unit manage cardiac sub-processes such as detection, prevention, diagnosis, staging, decision making, treatment, follow-up/surveillance, survivorship and rehabilitation processes.

The usage of social media networks help to disseminate patient's information, clinicians information; qualification, competence, skills, roles and availability and also useful in collaborative improved shared decision making, and also support learning perspective for patient, medical students, and healthcare professionals. The details of these sub-processes [9] are out of the scope of this paper. It may also use in panic

situation or disaster situation e.g. the website Flicker is used to evoke an outbreak disaster response, circulating images through social networks and allowing for a disaster response message to be conveyed widely, quickly, efficiently and in a user centric manner (Emmanuel and Day 2011).
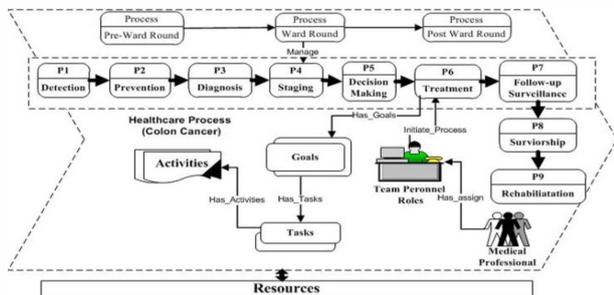

Fig. 1 Conceptualization of Healthcare.

4. METHEDOLOGY

To better understand and impact of social media networks (SMN) and its inclusion in healthcare knowledge management for the development of the Information system (IS). We proposed an approach to build practical framework which helps to incorporate usage of social media technologies in healthcare knowledge management for information system perspective.

4.1 Building a Social Networks Supported Knowledge Management: *An Ontological Engineering Approach*

This research paper presents a case study combining an ontology building methodology and two state-of-the-art Semantic Web platforms, namely, protégé, Top-braid composer and Java Jena API for the demonstration of FOAF ontology development in healthcare. Our model incorporates various concepts of healthcare domain and social media networks. According to the [5], "an ontology is an explicit specification of a share conceptualization of a domain which is machine readable and human understandable", and also helps to portable and for usage in the development of information system[28].
The ontological approach is used in the development of a knowledge base (KB) for healthcare domain when knowledge is provided by different sources such as social media networks sources such as social media applications and healthcare domain sources. The ontological approach is adopted customized method (CM) [9] for conceptualization which is the combination of Methontology [21]and Toronto Virtual Enterprise (Tove) [22] in healthcare domain. These aforementioned two state-of-the-arts are employed to create the Web Ontology Language (OWL) and Resource Description Framework (RDF) representation of the domain ontology respectively to enable its computer processing [25].

4.2 A Practical Framework for Social Media Networks supported Knowledge Management Systems (SMKMS)

This proposed framework is based on layers architecture which can be seen in figure 3. This layer architecture performs different functionalities which are discussed in the following section.
• 1st Layer. This layer is reserved for social media networks synergy with domain knowledge either in the form of tacit knowledge or processed knowledge through social media channels e.g. websites and social media applications.
• 2nd Layer. This layer highlights the importance of conceptual modelling and its different elements such as classes, instances, object properties, data properties and constraints using semantic web platforms e.g. protégé3, Top-braid Composer4.
• 3rd Layer. This layer explains about the ontological model implementation and some technical expects using web ontology language (OWL) and Jena APIs. The semantic platforms e.g. Protégé, Top-braid Composer can be used to load, edit and save ontologies in different format semantic web ontology languages including RDF7, XML8, TURTLE9, N-TRIBPLE10 and OWL11 [25].

This section explains about domain ontology development which provides systematic way for managing domain knowledge [29] in healthcare process especially in medical unit. The ontological model can be used for the development of information system (IS) in healthcare organizations. The ontological model also depicts the holistic view of different classes and sub-classes which qualify for the triple structure using standard ontology language (OWL) [24]. The triple structure <S, P, O> is helpful to justify the natural language expression which can be constructed with triplet set of <rdf:subject entity1>, <rdf:predicate Is>, <rdf:subject entity2> in ontology development using OWL [30]. The OWL ontologies can be categorized into three species or sub-languages; OWL-Lite, OWL-DL and OWL-Full. OWL-Lite supports users primarily needing a classification hierarchy and simple constraints features, e.g. OWL-Lite supports cardinality supports and least expressive sub-language. Similarly, OWL-Full is the most expressive sub-language [30]. The expressiveness of OWL-DL falls between that of OWL-LITE and OWL-Full (Cho et al. 2011). OWL-DL is also considered as an extension of OWL-Lite and OWL-Full an extension of OWL-DL [31].

The figure 2 explains a brief practical framework for proposed (SMKMS) architecture. This layers architecture supports healthcare process knowledge acquisition with the inclusion of social media networks which can be considered as core for healthcare services delivery in medical unit in healthcare organization. This layers architecture is embedded with OWL-based characteristics helps to develop conceptual model which is used for the representation of domain knowledge in machine readable format. e.g. RDF/XML. These mentioned layers are performing different

functionalities to achieve healthcare process services delivery according to the healthcare stakeholder; patient, practitioners, administration etc. needs and demands ward-round session.
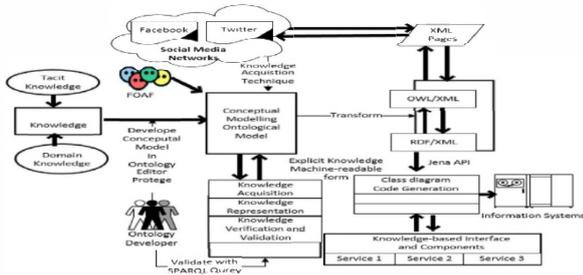
Fig. 2 Ontological-based Social Media Supported Framework.

3. EXPERIEMNTS AND RESULTS

This section illustrates about the findings; conceptual modelling and practical framework for healthcare knowledge management (KM) with the inclusion of social media technologies.

5.1 Ontological-based Social Media

This section presents aforementioned case study. The ontological-based social model gives the holistic view of healthcare process domain knowledge and usage of social media networks (SMN) in ontology development process [19]. The model specifically explains about success scenario where multidisciplinary professionals are divided into different teams and these teams are responsible to initiate different sub-processes of cardiac diseases in specific ward round (pre ward-round and post ward-round) sessions [9] in healthcare unit. These teams are consisting of consultant, additional nurse, head nurse, junior practitioner, senior practitioner, lab coordinator, occupational therapist etc. These multidisciplinary personnel with different assigned roles [9] perform various activities [9] in different tasks using different resources in ward round processes of medical unit.
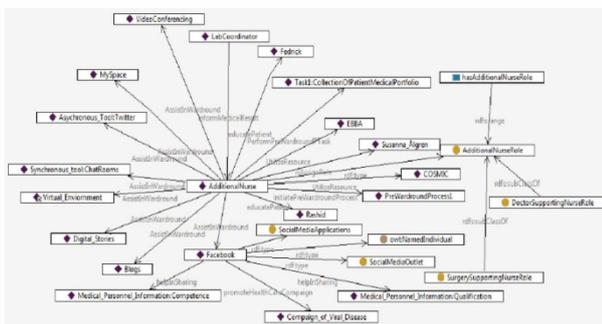
Fig. 3 Health-Social Networks supported Domain Ontology.

5.2 Health-Social Networks Domain Ontology

The above figure 3 explains the abstract view of one chunk of health-social network domain ontology in detail. The social media network supported knowledge management system (SMKMS) framework is developed by using customized method [20] which is combination of Methontology [21]and Tove [22] to build domain ontology. The health-social networks domain ontology shows some key concepts of the healthcare domain (ehealth, role, process, resource, tasks, medical ward, etc.) and certain activities which are carried out in ward-round process of medical unit e.g. pre-wardround activities, post-ward-round activities, ward-round activities, etc. and ad-hoc relationships among different entities of the domain knowledge. The constructed ontological model contains 658 classes or concepts, 254 object properties, 44 data property and 537 individuals (include statistics).

The ontological-based social model supports to healthcare stakeholders; patients, multidisciplinary professionals and their assigned roles [20] with different competences to achieve predefined goals by using various resources with social media networks synergy for accomplishing quality patient treatment in ward-round processes at Ryhov hospital, Jönköping, Sweden [20]. In reference to the development phase of ontology [23], we used semantic web platforms like protégé and top-braid composer to develop an OWL-based social model in healthcare sector. However , a specific assigned role in ward-round discussion is explained with success scenario, i.e. how a specific role performs certain activities in certain tasks to achieve certain goals in healthcare process (ward-round) as following; *Success Scenario:* Additional nurse role is assigned to participant A who is the part of working team in Ryhov, Hospital Jonkoping, Sweden and has some competences to perform different tasks and certain activities in different phases of ward-round process. Here, some main responsibilities are to utilize hospital resources and prepare patient medical history report and also assist to other medical colleagues and specially educate patient for the rehabilitation process through social media networks and applications in ward round session treatment.

Fig. 4 Success Scenario of Health-Social Networks Domain Ontology in Top-braid Composer Editor.

5.3 Evaluation Strategy

For the evaluation of the health-social network domain ontology, we utilized various strategies to evaluate the domain ontology model to achieve desirable results in healthcare medical unit. The transformation of the domain knowledge and synergy of social media networks in healthcare invites practitioners

and software developers to take model in the form of machine readable as foundation put the development of healthcare information system (HIS) in medical unit.

5.3.1 Using SPARQL Query

In this section, we chosen the SPARQL Query tab in Top-braid Composer to verify some competence questions. These competence questions help to domain users and experts to confirm authenticity of the domain knowledge and give confirmation that ontology has enough information for the development of knowledge base (KB) in specific domain [20][24]. The example of one competence question with SPARQL query and relevant results (see fig. 5).

The competence question; *which roles are utilized social media applications in healthcare process for patient treatment? Which roles are assigned to specific team while ward-round session? Which roles help to assist in ward-round?* These competence questions project the tacit domain knowledge which usually practitioners, clinicians and healthcare stakeholders acquire from the knowledge base by using semantic web query languages e.g. DL query[12], SPARQL[13] query etc.

Fig. 5 SPARQL Query Results.

Here, in figure-5, we used the SPARQL query structure that extend structure query language (SQL)[14] which helps to domain end-users and developers to access the information in the form of results from the knowledge repository in OWL file in ontology editor e.g. Top-braid composer. The results justify the competence questions according to the needs and demand of healthcare end-urers.

5.3.2 Demonstration of Community-based Social Networks

In this section, we developed the RDF version of the health-social network domain ontology with the Java Jena Ontology API we installed and configured the Jena API in the Eclipse Java Software development kit (SDK)[15] [25]. The figure 6 explains functionalities of the code which explains the interaction of community-based social networks in healthcare domain. The abovementioned code explains the interaction between healthcare practitioners, e.g. consultant, additional nurse etc. and patient with the help of *FOAF ontology*. FOAF is an OWL/RDF based user profile description technique which is used to represent information about users and their social connections [3][26]. For the reusability of FOAF (friend-of-a-friend) concept, we developed the FOAF ontology of some defined roles who are involved in ward-round process

and utilized it with core domain ontology.

Fig. 6 The Implementation of Community-based Social Networks in Jena API.

Presented, is the code in Java editor e.g. Eclipse which explains one of the features of framework (SMKMS) (See in fig. 2) with two functions; *differentFormat()* and *sparqlTest()*. First function with named *differentFormat()* executes the RDF information into different formats of semantic web ontology languages like RDF/XML, TURTLE, N-TRIPLE etc. Second function with named *sparqlTest()* helps to execute the RDF information by using SPARQL query statement according to desire requirement of domain user in healthcare study for competence question testing purpose. A complete explanation of the development of RDF/OWL with Jena API is beyond the scope of this research. Further information on how to use Jena API to develop ontology in RDF/OWL syntax could be found in [25][26][27].

6. CONCLUSION

The objective of this study is to highlight the importance of the social media Networks (SMN), technologies and its applications usage in healthcare domain. This study also elaborates value added impact of social media networks on healthcare stakeholders; patient, relatives, practitioners and administrator perspective. With the help of semantic web technologies and platforms, the ontological-based domain framework encompasses knowledge management practices and synergy of social media networks in healthcare domain can be considered as foundation for the development of information system (IS) which helps to improve information flow in clinical processes e.g. ward-round and also facilitates the end-users for timely information sharing, collaboration among domain experts and provides synchronized information for improved decision making in the healthcare processes (cardiac diseases) for quality patient treatment service delivery according to the end-users needs and demands.

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