Web 2.0 and Traditional Knowledge Management Processes

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Abstract: The paper discusses the use of Web 2.0 as a new means for knowledge management for professional organisations in general, and for emergency response in particular. It is argued that there is no clear understanding of how traditional knowledge management and Web 2.0 processes align. Thus, this paper analyses traditional knowledge management processes in the context of Web 2.0 processes and presents an alignment in a common knowledge management model. We believe that an understanding and alignment of the Web 2.0 and the traditional knowledge management processes is essential to fully realise the potential of designing and developing Web 2.0 knowledge management applications. The common model clearly shows where each Web 2.0 process can be applied, and thus the different characteristics of the Web 2.0 and organisational processes can be taken into account. Finally, we examine the application of Web 2.0-based knowledge management systems for emergency response and present the initial work on developing a tool to support knowledge management in emergency response. This tool is embedded in the context of the WeKnowIt research project that aims at examining how Web 2.0 techniques such as user generated content, question and answering and social networking can be applied in the emergency response domain.

1 Introduction

Organisations are becoming increasingly interested in the benefits of applying Web 2.0 technologies such as wikis, blogs, RSS, content sharing, tagging and social networking to their working practices. The organisations are going beyond the previous use of online communities to provide ratings, reviews and for other marketing activities. Online communities or Web 2.0 communities are people that share a common purpose and have guidelines (policies) for interaction [Pre00]. These social interactions are supported and mediated through computer systems. Organisations wish to gain advantage by engaging with a large community of users providing knowledge that can be leveraged into the organisations' strategies, products and services. However, for many organisations taking advantage of Web 2.0 communities will necessitate a cultural shift. Professional organisations such as enterprises and governmental agencies have strong and often legally enforceable rules and boundaries. The association of persons to the organisation and their role within it is typically clearly defined, such as head of the R&D department or human resource manager. In contrast, Web 2.0 communities are informal and ill-defined, an individual can have varying roles and degrees of interest in the community, which can alter over time. There is generally freedom of expression, rules and boundaries emerge from consensus

and are enforced by the community. Therefore organisations adopting Web 2.0 practices must move away from structured command and control systems towards collaboration and teamwork and from a process-centric to a people-centric model. To successfully exploit Web 2.0 communities, organisations must recognise the challenges and avoid the potential hazards. Thus, they must take the different characteristics of professional organisations and Web 2.0 communities into account.

To understand the effect of incorporating the heterogeneous activities carried out by Web 2.0 individuals and communities on decision making and process execution, organisations initially need to align Web 2.0 with their traditional knowledge management practices. To this end, this paper describes the analysis of organisational knowledge management processes and Web 2.0 communities. A brief summary of the four core knowledge management processes carried out by professional organisations is provided in Section 2. On this basis, we introduce the concept of Web 2.0 and analyse the activities carried out by end users in Web 2.0 communities in Section 3. We describe the different activities users carry out on Web 2.0 platforms in terms of knowledge management processes and align them with the traditional knowledge management processes of Section 2. In Section 4, we present a matrix aligning the identified Web 2.0 knowledge management processes with the processes of traditional knowledge management. The matrix shows concrete examples of different kinds of Web 2.0 platforms and applications, the knowledge management processes they support and how they relate to traditional knowledge management. In Section 5, we look at the practical application of the approach in this paper in the domain of emergency response. We present initial work into the development of a framework to incorporate Web 2.0-based applications for knowledge management in emergency response.

2 Traditional Knowledge Management

One of the most cited definition of knowledge [AL01] considers it distinct from data and information [SAA$^+$00]. Whereas data is the raw signals, information puts some meaning to it. Finally, knowledge puts a purpose to the information in order to achieve a specific goal within the organisation. To illustrate this distinction, one can consider the temperature of a fluid in a chemical production. If the temperature is interpreted as a numeric number such as 1723 it is data. Adding a meaning to the data, it becomes 172.3°C. Finally, this information can be considered as knowledge, if the worker in the chemical production realises that this temperature is too high for an optimal production process. Knowledge management (KM) is considered as the process of "leveraging the collective knowledge in an organisation" [vK98] in order to support the organisation in carrying out its activities. Over the last decades, a variety of frameworks to capture KM processes have been developed [HJ02]. A comparison of KM frameworks by Alavi and Leidner [AL01] shows that a set of four processes are commonly present: creation, storage and retrieval, transfer and application. *Knowledge creation* causes the existence of new knowledge, useful to solve problems or making decisions which were not possible before. *Knowledge storage* is the process of making the knowledge persistent in order to allow later access. *Knowledge retrieval* is used to support efficient access to the stored knowledge. The process of *knowledge transfer* is needed for providing parts of the organisation with knowledge, which was only available for other parts of the organisation before. *Knowledge application* is needed

to gain benefit from the knowledge by solving problems with the help of that knowledge. These four processes are used as basis for the subsequent analysis Web 2.0 from a KM perspective.

3 Web 2.0 from a Knowledge Management perspective

The concept of Web 2.0 [O'R05] is often referred to as an umbrella term, used to explicitly express the framework of ideas and technology it creates [And07]. An essential part of the Web 2.0 is user contributed content and knowledge creation. The user contributed content is collaboratively annotated (e.g. by tags), shared in social network platforms and collaboratively improved (e.g. in wikis) harnessing the collective intelligence of the individual users ("wisdom of the crowds" [O'R05]) and leveraging network effects [And07, O'R05]. The knowledge managed within Web 2.0 applications lies in content contributed by the users. This knowledge is published, enriched, shared, communicated and combined. From a KM point of view, the essential aspects of Web 2.0 can be summarised into six processes. These six processes where derived from an extensive analysis of related work in the field of Web 2.0 [SSK+08] that has been conducted earlier. For each process, representative examples of Web 2.0 applications are provided and its relation to the processes of traditional KM is identified.

In *knowledge syndication*, users publish their opinions, experience and knowledge to a broad community of recipients (mass media). The recipients can randomly access the information or subscribe to it. The knowledge producer is typically known to the recipients. Web 2.0 applications that support knowledge syndication are blogs, podcasts and news feeds. With respect to the traditional KM processes, knowledge syndication mainly deals with knowledge transfer, i.e. making pieces of knowledge of a person or organisation explicit and providing it to other persons and organisations.

The process of *collaborative knowledge creation* deals with joined creation of explicit knowledge resources, e.g. text or hypertext documents. In contrast to the knowledge syndication (where the authors of the knowledge are known to the consumers), this is typically not the case in collaborative knowledge creation. The group of users collaboratively creating the knowledge can be an open community such as the Internet users or closed such as a specific division of a company. A Web 2.0 application for collaborative knowledge creation is the use of wikis[1] in organisations and its collaborative creation of articles. Collaborative creation of knowledge mainly deals with the creation of (new) knowledge or at least making implicit knowledge explicit. Secondary purposes are storage/retrieval of the knowledge and the transfer of knowledge to other people and organisations.

The process of *collaborative knowledge exchange* deals with solving a problem an individual has by exploiting the wisdom of others. A description of the problem is made available to an open or closed group of users. The users can give hints, make suggestions how to solve the problem, give concrete solution directions and discuss about them. All feedback, hints, answers, and solutions provided are visible to all users of the community. Examples of Web 2.0 applications that provide for collaborative knowledge exchange are discussion forums and question and answering systems. The collaborative knowledge ex-

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[1]http://en.wikipedia.org/wiki/Wiki

change process focuses on knowledge transfer and knowledge application. The transfer of knowledge takes place by users providing their contribution to the problem solving process. The knowledge application happens when the user who stated the problem applies the suggested solution direction.

In the *knowledge and meta-knowledge sharing* process, users share their knowledge with a group of other users or an organisation. The sharing can be within a closed or open community. Users possess the knowledge they contribute and sharing typically comes in combination with creation and sharing of meta-knowledge. Meta-knowledge are descriptions of the pieces of knowledge, i.e. it is knowledge about knowledge. Typically tags are used as meta-knowledge. Although knowledge is also shared through systems such as wikis in form of the collaboratively written articles (see above), the main difference to collaborative knowledge creation is that the users still possess the knowledge they contributed. Meta-knowledge in wikis are, for example, different categories of articles such as definitions, how-to's, guidelines and business profiles. The process differs from knowledge syndication insofar as it is typically not about a "one to (very) many" relationship as with, e.g. mass media. Web 2.0 applications that allow for knowledge and meta-knowledge sharing are content sharing systems like Flickr[2] and YouTube[3]. The knowledge and meta-knowledge sharing process mainly refers to the knowledge transfer process defined in Section 2. It provides insights into the knowledge of other users, which can be then consumed and acquired. In contrast to the collaborative knowledge exchange, application of knowledge is not in the (primary) interest of knowledge sharing systems. Rather, the purpose is to make the knowledge available and provide for a longer term storage and retrieval.

In the *social networking* process, users typically provide some personal information such as interests and affiliation(s) and share it with the community. In addition, the users can explicitly state that there is a connection between themselves and other users (contacts). These connections can be of different kinds such as friends, collaborators, or university mates. Social networking applications such as Facebook[4] typically focus on end users. There are platforms targeting the profession user like Xing[5] and members of specific organisations like emergency response personnel such as Sahana[6]. Considering social networking with respect to the traditional processes of KM defined in Section 2, the main relation can be seen with knowledge storage and retrieval (finding persons I am interested in). It also supports the creation of knowledge (the social network itself). Another, secondary, purpose of social networking is the transfer of knowledge.

Finally, the *knowledge orchestration* process implements the combination of different open infrastructures and thus merging different resources of knowledge to create a new service and to provide better insights into the knowledge. It can be used for better exploring knowledge and its combinations; often achieved with maps, timelines or diagrams. Web 2.0 applications making use of knowledge orchestration are typically called "mashups", providing a (predefined) combination of different knowledge sources. The process of

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[2]http://www.flickr.com

[3]http://www.youtube.com

[4]http://www.facebook.com

[5]http://www.xing.com

[6]http://sahana.lk/

knowledge orchestration allows for knowledge creation through combination of existing resources. The goal of this combination is knowledge transfer and knowledge application. Transfer of knowledge means that by accumulating the knowledge and presenting it through different visualisations, it can be perceived and acquired.

4 Aligning Knowledge Management and Web 2.0 Processes

Seemingly, the six processes identified for Web 2.0 applications have a correlation to the four core processes of traditional KM. The matrix depicted in Figure 1 shows this correlation. The x-axis shows the four traditional KM processes and the y-axis depicts the six Web 2.0 processes. Given this matrix, the majority of Web 2.0 support for traditional KM lies on the knowledge transfer. Here, we find all Web 2.0 applications introduced. The process of knowledge creation and knowledge storage and retrieval are supported by fewer Web 2.0 applications. Both can be facilitated by wikis and social networking applications. While Knowledge creation is additionally supported by knowledge orchestration, knowledge storage and retrieval can be improved by knowledge and meta-knowledge sharing. Finally, Web 2.0 methods can give only minor support for knowledge application by methods of collaborative knowledge exchange and knowledge orchestration. Although not all processes of traditional KM are equally supported by Web 2.0 applications, one can conclude that indeed KM can benefit from the Web 2.0. Involving Web 2.0 brings in interesting and aspects for KM in professional organisations such as in the case of emergency response.

Knowledge Management / Web 2.0	Knowledge Creation	Knowledge Transfer	Knowledge Storage/ Retrieval	Knowledge Application
Knowledge Syndication		Blogs, Podcasts, News Feeds		
Collaborative Knowledge Creation	Wikis	Wikis	Wikis	
Collaborative Knowledge Exchange		Discussion Forums		Discussion Forums
Knowledge and Meta-Knowledge Sharing		Sharing and Tagging of Content	Sharing and Tagging of Content	
Social Networking (SN)	SN Applications	SN Application	SN Applications	
Knowledge Orchestration	Mashups	Mashups		Mashups

Figure 1: Traditional KM processes aligned with Web 2.0 processes and its applications

5 Web 2.0 Knowledge Management for Emergency Response

There are many different types of emergencies, brought about by forces of nature such as floods or man-made like terrorist attacks. These emergencies vary in terms of scale, both in severity and affected location. In small scale emergencies, only a few organisations may be involved, typically only local authorities such as the city council, police

and fire department. During large scale emergencies several hundred organisations can be involved, as was the situation after the Tsunami in the Indian Ocean 2004 [HRRL08]. During an incident, the emergency response (ER) team may receive information from multifarious sources like the emergency services, other local authority bodies, government bodies, broadcast services, affected individuals and others. The seriousness of an incident is likely to increase as its scale and complexity increases. However, in such situations it is more likely that the amount of information received will become overwhelming. The ER team's decision making process can, literally, mean the difference between life and death. Primarily this means the allocation and coordination of resources, but also involves effective communication between the agencies involved, the decision/command chain and the affected individuals. The management of the mass of information is crucial in aiding this decision-making, ensuring, as far as possible, that the responders have full *situational awareness* (i.e. having accurate, complete and real-time information) to make informed decisions. This means, in KM terms, knowledge creation and transfer are critical providing an effective response.

A number of recent initiatives are exploring the use of Web 2.0 to aid KM in ER. The Responder Knowledge Base[7] aims to provide information related to ER such as grants, standards, products and to provide functionality for users to add content and to contact other users. Life360[8] is a multi-channel messaging system and neighbourhood-centric social network to keep the user up-to-date and in contact with family and local community, using customised emergency alerts. The US Federal Emergency Management Agency has teamed up with MySpace to distribute a tool which provides information on how to get help, locate victims, facilitate donations, register volunteers and track the approach of a hurricane. A Facebook group for "emergency awareness" was set up in July 2008 at the University of Maryland. The group has been used to publish any emergency message that the university issues on its other alert systems. Again developed at the University of Maryland, project 911.gov[9] aims at developing a Web 2.0 platform supporting the collaboration of organisational entities for ER and citizens. A recent Open Source system, Sahana[10], provides a Web 2.0 platform for connecting ER organisations with volunteers. This platform is aimed at the setup of an online community by an organisation for a specific (large scale) incident.

Given the pressing need for knowledge creation and transfer in ER it is unsurprising that the incorporation of Web 2.0 techniques into ER has focused on the use of social networks; these can be seen as particularly applicable to these KM processes. It is worth noting that there has also been an investigation into the use of wikis in ER [WPAM$^+$08], although the work concluded that wikis are useful, there were some caveats. Wikis are generally used for the monotonic creation and improvement of knowledge and are less applicable in dynamic domains, such as ER, where the recency of knowledge is often crucial. The analysis in Section 3 indicates that other Web 2.0 techniques such as blogs, podcasts, newsfeeds, forums, content sharing, tagging and others could also provide potential benefit to ER. The

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[7]https://www.rkb.us/

[8]http://www.life360.com/

[9]http://www.cs.umd.edu/hcil/911gov/

[10]http://www.sahana.lk/

WeKnowIt project[11] aims to examine how these other techniques (along with social networking) can be applied in the ER domain. One of the main catalysts for the work in the WeKnowIt project is the realisation of the benefit user generated content (UGC) can bring to ER. Rather than relying on the limited resources of professional organisations to gather information, social network sites provide access to a mass of individuals who are directly involved in the incident. With the advent of mobile interfaces to social networks, users can upload information directly from the site of the incident, thus providing real-time critical information about the event and the possibility of having a clearer geographic visualisation of the extent of the emergency. In fact, for a number of recent earthquakes it has been claimed that Twitter[12], a micro-blogging service, provided the first notification and pictures related to seismic events before the national broadcast services or even professional ER organisations[13]. An interesting current investigation into the use of UGC is the The Aberdeen Project [Dod08] by the BBC which, although not directly an ER organisation, acts as a crucial medium between ER organisation and the public during emergencies.

The use of UGC in ER presents a number of challenges and hazards. Whilst ER organisations engage in KM processes that aim to generate and distribute accurate information, UGC may not adhere to the same criteria. Users may post information that is speculative rather than definitive, or simply incorrect or misleading. Where incorrect information is transferred from a social network setting and used or reproduced by an organisation the effect of any misinformation may be more serious. In addition to the issue of incorrect information, the nature of information is subjective, therefore individuals and ER organisations will have different perspectives and place different degrees of importance upon a given incident. For ER organisations to successfully exploit UGC in its KM they must implement processes to ensure the knowledge meets the requirements with respect to relevance, reliability and quality of the organisation.

6   Knowledge Management Tool for Emergency Response

To take up these challenges and to provide solutions to these hazards, we are developing within the WeKnowIt project a KM tool for ER. In the following we show what kind of ER activities such a tool should support and how they are implemented in our current version of the KM tool. The purpose of the KM tool is to support professional ER organisations in accomplishing their goals. But it should also seamlessly integrate information and content provided by the citizens, e.g. by using mobile phones. The core activities that are carried out by the ER organisation are: management of organisational structures, incident management (including communication with the citizens) and task management.

Management of organisational structures is the activity of setting up the ER team and informing other organisations after the incident is confirmed. The selection of the ER team members and involvement of other ER organisations depends on the type of the incident such as severe flood, fire in an apartment or terrorist threat. The organisational structures can change during an incident. For example, if unforeseen problems are encountered such as additional help is required to prevent a damn burst, the military is called.

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[11]http://www.weknowit.eu
[12]http://twitter.com/
[13]http://www.bbc.co.uk/blogs/technology/2008/05/twitter_and_the_china_earthqua.html

Our KM tool supports the definition and modification of organisational structures in terms of groups and subgroups, in which the involved ER entities and members can be included. In future, we plan to allow the import of other organisations like non-governmental organisations and Web 2.0 communities like local neighbourhoods.

Incident management comprises the activities carried out by the ER team to capture and represent the state of the incident as best as possible and make decisions based on it. Therefore incident related knowledge maintained by members of the ER organisation is collected. This knowledge comes from the professional entities like the floating liaison officers of the emergency control centre send out to verify a situation or other professional entities such as the police and fire department. However, the knowledge also comes from citizens, those people in need calling the emergency authorities via mobile phones or volunteers helping the professionals in alleviating the problem. Knowledge is clustered, aggregated and used by the ER team for decision making. Here, one important piece of knowledge is the incident log, comprising the time line and notes of important events.

The WeKnowIt KM tool provides the functionality to maintain a shared incident log. We plan to add spatial and temporal dimensions and keywords to structure this knowledge in order to facilitate search and retrieval. We will also integrate external plugins for analysing and visualising the collected incident knowledge that comes from citizens and other Web 2.0 users.

Task management comprises all activities to allocate the work within the ER organisation. Typically such tasks include informing other ER organisations or gathering of important information, like the water level of a rising river at a specific location. The ER personnel also organise their individual tasks to maintain an overview of what is to accomplish and when. Therefore, tasks can be defined, described and assigned to persons in our WeKnowIt KM tool.

The screenshot in Figure 2 depicts a view on the task management module of the WeKnowIt KM tool. The head of the emergency control centre Sarah Armstrong is logged in. In her task view, she sees on the left hand side all tasks she is working on. On the right hand side, an overview of tasks issued by Sarah is shown that she delegated to her colleagues. The details of the task "Water level at Downing Street" are shown. They include a task description and the time and date the task was issued, a task priority and the executor of the task. Some water levels are entered here as task result (indicated by the filled star) that Sarah can constantly check.

Relation to Traditional KM and Web 2.0 Processes The three ER activities described above are related to multiple of the traditional KM and Web 2.0 processes presented in Sections 2 and 3. In the following, we align the ER activities along the matrix presented in Section 4. The ER activity of managing organisational structures supports the traditional KM process storage and retrieval in combination with the two Web 2.0 processes collaborative knowledge creation and social networking. This is achieved by supporting storage and retrieval of organisational structures, the collaborative creation of the ER organisations, which themselves can be considered as a type of social networks. Incident management as another core activity of ER supports the three traditional knowledge management processes creation, transfer and storage and retrieval. It also makes use of the Web 2.0 pro-
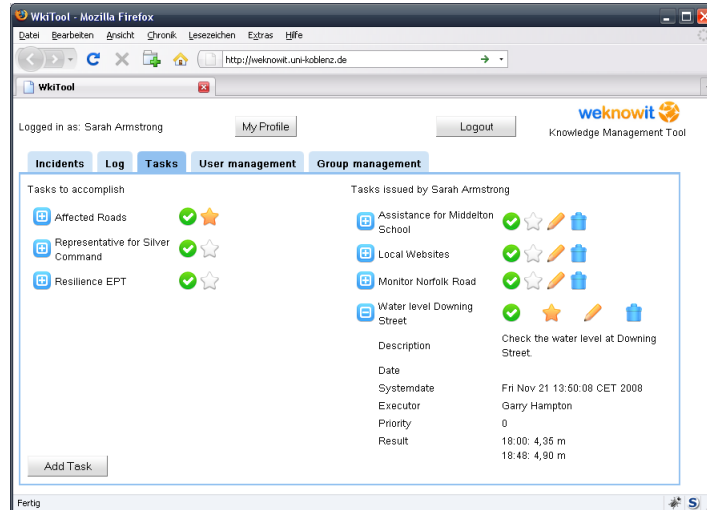
Figure 2: Screenshot of Task Management View in the Knowledge Management Tool

cesses collaborative knowledge creation and knowledge and meta-knowledge sharing. The (collaborative) knowledge creation is supported by creating the incident log and collaboratively adding entries to the log. The knowledge is stored by the tool and can be retrieved. Knowledge transfer happens when ER personnel read the incident log entries. This can be considered also as a form of Web 2.0 knowledge sharing. Finally, meta-knowledge in our tool are the time and creator of the log entries. The activity of task management supports the traditional KM processes of knowledge transfer, storage and retrieval as well as application. To this end, it makes use of the Web 2.0 process of collaborative knowledge exchange. Once a task is entered into the tool, it is stored and can be retrieved. The recipient of the task applies knowledge provided with and required for the task. Once the task is accomplished, the gained knowledge is transferred by entering it back into the task management of our tool. Thus, the task management can be considered as a collaborative knowledge exchange. In addition, the WeKnowIt KM tool is extensible towards knowledge syndication, e.g. to inform citizens via RSS news feeds or sending them messages on their mobile phones. It can also be extended towards knowledge orchestration through, for example, the visualisation of combined knowledge sources on a map, e.g. geo-referenced photos together with the phone calls of citizens.

7   Conclusion

This paper investigates the use of Web 2.0 by professional organisations for carrying out their knowledge management tasks. It is viewed from the perspective of the four traditional knowledge management processes: creation, transfer, storage and retrieval, and application. These processes are aligned with Web 2.0 processes. We believe that a clear understanding and alignment of the Web 2.0 and the traditional knowledge management processes is essential to fully realise the potential of designing and developing Web 2.0

knowledge management applications. It allows to take the different characteristics of the Web 2.0 and traditional organisational processes into account. We examined the application of Web 2.0 to knowledge management in emergency response. There are a number of interesting applications in this area. However, they almost entirely focus on the use of social networks, whilst other Web 2.0 processes also offer potential benefit, especially for knowledge transfer between Web 2.0 communities and emergency response organisations. We presented an initial implementation of a Web 2.0-based knowledge management tool for emergency response. This knowledge management tool is to be seen as first step towards a sophisticated support for creating, sharing and using of emergency-related knowledge by the emergency response organisations.

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