Web 2.0 Tools to Support Decision Making in Enterprise Contexts

Raquel Ureña and Enrique Herrera-Viedma

Department of Computer Science and Artificial Intelligence
C/ Periodista Daniel Saucedo Aranda s/n, 18071, Granada
{raquel,viedma}@decsai.ugr.es

Abstract. Nowadays Web 2.0 provides users a unique framework not only to find information but also to express their opinions and collaborate and interact in real time. Web 2.0 includes applications such as blogs, wikis, RSS, pod-casting, mashups, and social networks. These applications aggregate the collective intelligence of millions of users and therefore new tools to develop decision making processes adapted to the new virtual environments need to be developed. In this contribution we analyse how Web 2.0 tools are used to improve cooperation and social decision making in the enterprise context and what are the challenges that need to be accomplished to take fully advantage of them.

Keywords: Decision making, Web 2.0, Enterprise 2.0

1 Introduction

We live in a world where technology has changed the way people communicate, interact, get information and do business. Web 2.0 is the common term for advanced Internet technologies and applications including social networks, blogs, wikis, RSS, podcasting and mashups. All these tools and applications are often known as Social Media Technologies, SMT [12]. One of the most significant differences between traditional Web and the Web 2.0 is that in the latter the content is user generated, and there is greater collaboration among Internet users.

Web 2.0 communities provide a framework to collaborate, negotiate, communicate, and interact allowing their users to take advantage of values such as democratic participation, collaboration, collective intelligence and knowledge sharing on a massive scale beyond geographical barriers. All these values are extremely useful in social decision making processes which consist on the extraction and aggregation of individuals' information to generate a global solution. Therefore Web 2.0 communities are considered as very powerful tools for decision support systems. This enormous on-line collective provides two potential benefits: Firstly, such a large, dispersed population captures statistical collective intelligence which leads to the knowledge generation through the weighted averaging of independent, individual judgements; and secondly, some systems benefit from the ability to amplify expertise. That is , if each individual in a collective

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is more likely than not to be correct, then as the size of the group scales, the probability of the collective decision being correct moves toward certainty [5]. From the point of view of the industry many believe that understanding these new applications and technologies and using their benefits early will stand organizations in good stead to greatly improve internal business and decision making processes.

In this paper we analyse how the Web 2.0 communities are used to improve collaboration and decision making in the enterprise contexts. So, the paper is set out as follows. Section 2 describes how the most outstanding Web 2.0 technologies have become very powerful tools to support decision making systems. Section 3 shows the utilization of the SMT in enterprise contexts, discussing its advantages and drawbacks. In Section 4 we present current trends and challenges of the utilization of SMT technologies in collaborative environments. And finally, Section 5 points out our conclusions.

2 Web 2.0 Communities

New Web 2.0 technologies have provided a new framework in which virtual communities can be created in order to collaborate, communicate, share information, resources and so on. This very recent kind of communities aggregates the collective intelligence of their users existing on the Web to extract information such as behaviours, opinions, popularity, trends, knowledge and customs [16]. Particularly, some of the most common on-line Web 2.0 communities are:

1. **Folksonomy** is a tool for information retrieval which connects users to resources via tags. A tag can be seen as an interpretation that a user makes about a particular resource. Folksonomies are generated indicating the popularity of a particular term to describe a particular resource. Folksonomies such as del.icio.us provide the user with a personalized view of the emergent structure of the Web and the user' self interest improves its ability to do the same for others. Another example of folksonmy is CiteULike, a social bookmarking site for academic context which organizes users' favourite papers into a personal library that any other user can consult. Thus, every user's library serves as that user's bookmarks as well as an impersonal recommendation list for other users who have liked one or more resources in that library.
2. **Recommender systems** manage information overload by acting as a search function to provide a personalized subset of the total collection. They are personalized because they track each user behavior, pages viewed, purchases, and ratings to come up with recommendations. Most recommender systems rely on an item-item algorithm, which calculates the distance between each pair of items according to how closely users who have rated them agree. Distances between pairs of items are usually based on the ratings of thousands or millions of users, so they tend to be relatively stable over time. Some popular recommender systems are: Amazon which offers personalized suggestions to

their on line shoppers, Netflix which suggests videos to watch, Facebook's friend suggestions, Last.fm which ic a popular music website based in the United Kingdom, and Pandora which builds personalized music streams.

3. **Discussion forums** represent Web online discussion communities where users share information or discuss about selected topics. In many of these communities some simple group decision making schemes, as referendum or voting systems are usually used. For example, services like PollDaddy allow to create online surveys and polls where users can vote about the best alternative to choose for a given decision problem. Moreover Smartocracy [13] is a social software system for collective decision making. The system is composed of a social network that links individuals using trust degrees and allows to make good decisions and a decision network that links individuals to their voted-on solutions.
4. **Wiki** is a server software that allows users to freely create and edit Web page content using any Web browser. It is a highly distributed way to gather, create, and share knowledge. Its main purpose is to capture the collective knowledge held by participants such that the resulting documents transcend the abilities of individual contributors. The result is a network of collaboratively generated documents that contains the authorial wisdom of all its contributors. Wikis provide a new way of solving problems based on a transformation on the way the knowledge is generated, shared and stored. There are no any automatic mechanism to leverage Wikis in decision making environments. However their capability of organizing and storing information from multiple users in a dynamic way converts them in a excellent complementary tool to support decision making processes. The most outstanding example of a Siki based system is the online encyclopedia Wikipedia. In [1] a consensus model designed for Web 2.0 communities and its application in Wikipedia were presented. This model is aimed to minimize the main problems that this type of communities present such as low and intermittent participation rates, difficulty of establishing trust relations and so on. This model includes some delegation and feedback mechanisms to improve the speed of the process and its convergence towards a solution of consensus.
5. **Social networks** are the major achievements of the Web 2.0 technologies. They are Web sites where people create their own virtual spaces (or home page), on which they post pictures, write blogs, share ideas, and link to other Web locations which they find interesting. As a result, they form online communities comprised of people who share similar interests. There is a wide range of social networks with different targets, from Web sites to share personal information with friends, to places where you can expose your professional capabilities, or even places to share your opinions about your trips.

3 Enterprise 2.0

It is widely known that incorporating social business is becoming imperative to improve customer communication and engagement, build loyal partner networks

and improve internal collaboration. Enterprise 2.0 refers to the deployment of Web-based social software tools and services, such as Wikis, blogs, forums, RSS feeds, opinion polls, community chats and social networking, to facilitate enterprise collaboration. It includes social and networked modifications to corporate Intranets and other classic software platforms used by large companies to organize their communication.

3.1 Using Popular Web 2.0 Tools in the Business Context

Most popular social networks can facilitate knowledge management and transfer in complex, dynamic enterprise environments by developing new relationships between colleagues of the firm or from other firms, advertising new products as well as attracting prospective clients [12]. Some examples are:

1. **Facebook:** Using Facebook in the organizational environment leads to establish relationships with colleagues inside across the firm and outside the firm providing a way of expertise sourcing an sharing. It offers the possibility of advertise products, spreads the employees' network and attracts prospective customers or clients.
2. **Twitter:** In an enterprise context, Twitter is useful for employees to share expertise, post progress updates and rapidly disseminate information. It is interesting to note the rise of Twitter in all types of enterprise social networking.
3. **LinkedIn:** It is a professional oriented social networking site that allows users to share expertise and gain new insights from discussions with like-minded professionals in private groups. In many companies LinkedIn is used both to recruit talents and identify sales leads. For example, IBM provides knowledge sharing via LinkedIn answers and its own social network.
4. **Blogs:** A blog is as a web based journal authored by one of multiple writers, which serves as a platform to articulate thoughts , feelings, ideas observations and issues of relevance. Readers can contribute responding to posts as comments. Blogs sparks conversation and debate and enables to share knowledge and information.
5. **RSS feeds:** They provide a channel for subscribing to content sharing common social tags. That enables visibility of content and allows information providers to syndicate their content.
6. **Google aps (Google Docs and Google Groups):** Google Docs allows users to create word-processing, spreadsheet and presentation applications that are Web-hosted and can be remotely accessed by any authorized user. These documents can be edited simultaneously by multiple users. On the other hand, Google groups allow an extension of Google Docs into collaboration space where users can create, share, and work on documents as well as start discussions, upload multi-media files and manage content.
7. **Wiki:** Wiki technology is increasingly being used in corporate environments to facilitate a variety of organisational tasks that include the codification of organisational knowledge and the formulation of corporate communities

of practice, as well as more specific processes such as the development of collaborative information systems, the interactions of the enterprise with third parties, management activities and organisational response in crisis situations [11].

3.2 Enterprise SMT Based Tools

While social networking's success among consumers is well-known, enterprise social media tools are still struggling to gain a place in organizations. However companies are starting to recognize the potential value that enterprise social media technology can deliver, particularly around departmental and cross-department collaboration [8]. Enterprise social media technology adapts and combines features such as employee profiles, activity streams, microblogging, discussion forums, Wikis, groups of friends, tagging, rating and reviewing of content for workplace use with the primary goals of better connecting members of an organization and promoting knowledge-sharing between different employees and departments.

Although Facebook and LinkedIn have avoided tailoring their products for corporate use, there is a wide range of tools supporting enterprise collaboration which goes from point solutions like Yammer and Socialcast to SaaS-based solutions like Salesforce.com's or Chatter, and solutions from well known companies like Microsoft, IBM, and Cisco. In the Gartner, Inc.'s 2012 Magic Quadrant for Social Software in the Workplace we can find 21 ESN Vendors classified as niche players, challengers, visionaries and leaders. Among them we can highlight:

1. **Cisco's WebEx Social**: This tool provides a secure, business-focused Facebook-like experience compatible with other Cisco's communications platforms, such as WebEx conferencing, Jabber and Cisco Unified Communications Manager. This tool is mainly focused on networking, employees can follow one another, and finding an expert in an area becomes as simple as a Google search.
2. **Microsoft's Yammer and SharePoint:** On the one hand, SharePoint is a repository of business documents and institutional knowledge. Files can be uploaded, shared, archived and edited, while Wikis and discussion threads can help capture conversations for posterity. On the other hand, Yammer covers real-time interactions with a series of mobile and Web applications that combine the simplicity of Twitter with more extensive features, such as organizational chart mapping, polls and groups. Microsoft is working on the integration of both platforms.
3. **IBM connections:** It is a secure social software platform that helps employees engage with networks of expertise, and integrates business processes. Users can quickly set up their own profiles, create and manage groups and share files, status updates and wiki pages. Users can access this platform everywhere from desktop or mobile devices. Over time, connections become an expertise repository. That is, it allows users seeking out and finding the answer to their questions or else quickly discovering who might have the

answer based on profiles or past discussions. The key capabilities of these platform include Activity stream with the most relevant events on the user's network and social analytics for connection components which provides new trends in content, social activity and expertise for better decision-making. It also provides a team oriented platform to keep in touch all the members in a project including also the main tasks and milestones for the project.

4. **Socialtext:** It is a social software which provides the employees with facilities to create, share and manage content, and effectively collaborate within their enterprise. It offers capabilities to generate and edit content, such as blogs, wikis, activities, etc., and automates the ability to create pages and track their progress along the way. Moreover it helps employees to find the most relevant people in their network to connect and collaborate with. Socialtext makes it easy to integrate with other enterprise tools such as CRM (Customer relationship management), ERP (Enterprise resource management), HR and content management systems.
5. **Jive:** It is a social business platform which enables people to connect, collaborate and communicate from anywhere. From the point of view of the employees inside companies Jive provides collaborative employees' networks. Externally, it supports customer communities to improve service, support and customer satisfaction. This platform also encourages the engagement and participation by using built-in game mechanics and rewards. Moreover it provides on-line support to quickly capture and share new ideas by brainstorming including voting and rating mechanisms and includes task planning tools.
6. **Salesforce.com:** It is a cloud based software which provides a Customer Relation Management platform as well as engage clients, employees and sales representatives on a social network. It includes a social networking plug-in that enables the user to join the conversation about their company on social networking Web sites, provides analytical tools and other services including email, chat, and accesses to customers' entitlement and contracts. This solution is comprised of several tools: Sales, Service Cloud, Data Cloud (including Jigsaw), Collaboration Cloud (including Chatter) and Custom Cloud. The sales cloud is a real time collaborative tool which enables users to control all the relevant information related to the company's sales process. It is designed to manage marketing campaign spending and performance across a variety of channels from a single application, tracks opportunity-related data including milestones, decision makers and customer communications. Chatter is a real-time collaboration platform which provides the users with updates via a real-time news stream. Users can also form groups and post messages on each other's profiles to collaborate on projects.

Table 1 summarizes the main characteristics of the tools explained above.

3.3 Advantages of Enterprise 2.0

Using SMT in the companies context exhibites substantial benefits which range from the way in which the information is spread and shared to the new way

Table 1. Enterprise 2.0 Tools

Tool	Main characteristics
Cisco's WebEx social	Facebook like experience
	Focus on networking
Microsoft's Yammer	Real time communications
	Mobile version
	Microbloging
	Support for groups collaboration
	Polling system
Microsoft SharePoint	On line repository of business document
	wiki
	discussion threads
IBM connections	Social software platform
	users' profile
	document sharing
	Activity stream
	team support
	social analytics
	wiki
Social text	facilities to create, share and manage content
	user's profile
	expert finding
Jive	provides collaborative employees' networks
	supports customer communities
	Encourages the engagement using built-in game mechanics and rewards.
	On line support to brainstorming
	Polling system
	tasks planning tools
Salesforce.com	Cloud based solution
	Social network for employees,clients,and sales representatives
	Analytical tools

in which the problems are solved taking advantage of the collective intelligence and fostering the mass collaboration [15]. In the following subsections these advantages are analysed posing some real examples of companies which leverage Web based collaboration tools.

1. Improving Communication, Collaboration, and Advertising: Among the various possible outcomes of incorporating SMT is the possibility to easily share information within different departments of an organisation allowing a constant stream of user defined data and developing an ambient awareness of other's behaviours as well as increasing the potential discovery of knowledge from previously unconnected sources. SMT also makes possible the exchange of information outside the organizational boundaries, with organizations and institutions that have a previous relationship with the company, offering a mechanism whereby contractors can develop and maintain relationships and share knowledge and information beyond the exact terms of the service agreement regardless of the affiliation or geographical dispersion. In such a way, companies can obtain customers' feedback.

These ways of communication are also exploited to advertise products and attract new clients, and therefore, reducing the advertising cost while targeting a bigger audience. In such a way, Social networking sites give businesses a fantastic opportunity to widen their circle of contacts allowing organizations to reach out and select groups or individuals and target them and their network of contacts personally boosting the companies reputation. Some examples of the corporate use of social networks for marketing activities can be found in [17,9].

Companies can use Wikis to supplement regular collaboration tools within its global teams and cross department collaboration. Blogs for communication and sharing within the members of the company but also with the clients and RSS feeds for news and business information dissemination. Using forums and discussion groups firms can also obtain feedback from their customers about their products and identify what should they improve or even get ideas about new products. In a recent survey about using SMT in the working environment majority of the respondents agree on that social communities could improve collaboration project work helping employees to get quicker answer to their questions and to easily find experts on relevant topics. Moreover they felt that the use of SMT could help with information overload by lowering the amount of email traffic, diverting instead to more open approaches of communication.

2. Support to Decision Making: SMT based tools can provide support for managerial decision making through analysis of the data collected in social networks. Typical examples include identifying key performers, locating experts, soliciting ideas, developing possible solutions to complex problems (e.g., using the answer functions on LinkedIn), and analyzing managerial connection networks to facilitate succession planning. Furthermore, some data from SMT are analysed by firms using data mining and machine learning procedures to track behaviours and explore new trends to recognize current problems and develop

new products. Some examples of companies which use SMT for managerial issues are: (i) Deloitte Touche Tohmatsu's social network (D Street), which was established to assist the company's human resource management team in downsizing and regrouping, building networks of experts, and retaining talents [3]; (ii) Hoover Inc. has established a social network that makes use of Visible Path's relationship management technology to identify target business users to build relationships and discover ways to reach specific users; (iii) Ypodimatopoulos et al. presented in [18] a problem-solving application for discovering expertise by leveraging the professional social network of its employees.

3. Training and Learning: Some companies employ virtual worlds, for training purposes since they allow training via virtual simulation. For example, Cisco makes use of Second Life on its virtual campus for product training and executive briefings, and IBM offers training exercises to its field service teams through the simulation of project management and customer interaction in virtual worlds. Not only enterprises but also other well-known institutions such universities leverage social technologies to develop virtual campus in which students and professors can collaborate and share information.

4. Knowledge Management: These applications involve employee-driven activities such as knowledge discovery, idea creation, maintenance, sharing, transfer, and dissemination. Areas of application include the discovery of experts and the mapping of communities of expertise. These large-scale activities are known as *crowdsourcing*, *collective intelligence, mass collaboration,* and the *power of the crowd* [10]. A good example is innocentive.com, a social network that attracts the participation of a huge community of scientists to solve science-related problems, usually for a cash reward.

Furthermore, many companies have created retiree corporate social networks to take advantage of their knowledge and expertise. These former employees possess huge amounts of knowledge that can be used for productivity increases and problem solving.

3.4 Risk of Using Social Media Technology in the Enterprise 2.0

The threats and the exposure to security and business risks, arising from careless employees engaging in online communities is now an issue of great relevance for enterprises: Employees can disclose not only their personal information but also confidential business data. In this context, enterprises face not only productivity loss due to employee spending time using SMT; a greater concern is the possible threat of information leakage caused by incautious posts or explicit references to private business information [14]. The audience of SNs is so broad that besides customers, business competitors, and partners, also hackers may access such information, potentially gaining competitive advantages and causing the targeted enterprise financial losses, both in the short and long term. The risk of attackers

exploiting SMT data warehouses is on the rise, due also to the tools available to them (e.g. data aggregator and data mining tools). In table 2 we summarize the main pros and cons of using SMT in the work place.

Table 2. Pros and concerns of using Enterprise 2.0 tools

Pros	Cons
Expanding market research	Security risks
Low cost marketing	Viruses and malware
Expertise source	Low productivity
More eficient communications inside and outside the firm	High investment in social software
On line training and learning	Reputation and legal liability
Sharing expertise	Information leackage
Better organization of knowledge	Employees reluctance to use SMT
Faster way to attract new clients	
Easily select groups or individuals and target them personally	
Easily way to keep up to date	
Improving collaboration	

4 Trends and Future Work

We are at the very beginning of the utilization of SMT technologies in collaborative environments such as the enterprise. Therefore, there are still many potential research issues. Most of them are especially aimed to bridge the gap between big data and big strategy, that is to take advantage of the massive volume and detail of information captured by enterprises, the rise of multimedia, social media, and the Internet of Things.

4.1 Development of New Tools to Support Computer Assisted Decision Making Adapted to the Web 2.0 Communities

We identify as a key challenge the development of new tools and algorithms to support computer assisted decision making taking advantage of web 2.0 technologies, and integrate these tools in the already existing platforms. These tools should be able to provide better "participation architectures" that allow sharing data, trusting user as co-developers, harnessing collective intelligence, etc... as well as overcome some of the inherent problems of the Web 2.0 communities such us large user base, heterogeneity in the users' background, low and intermittent participation rates, the dynamism of the Web 2.0 frameworks and difficulty of establishing trust relations. Moreover some validation tools must be developed to assess the quality of the decision process and the validity of the obtained results.

4.2 Expertise Seeking Using Web 2.0 Technologies

A a key aspect in many business and engineering contexts is the appropriate selection of the experts and the way their opinions are aggregated depending on

their background, expertise and the quality of the opinions provided. In many big companies they have a huge staff world wide and sometimes, they struggle to find the most suitable experts to be integrated in a work team or take part in a decision making process. Therefore, new tools to find experts using companies' staff data-bases or web-based scientific- academical networks such as Google Schoolar, the Web of Knowledge or DBLP need to be developed. In such a way, the selection of experts whose background really fits the problem to be solved would be ensured.

4.3 Using Big Data to Improve the Decision Making Process

Many decision making problems require gathering and analysing information to define the problem and identify possible solutions. To do so, it is required to obtain the opinion of people such as clients, prospective users or even knowing the general opinions and trends. Traditionally, to get clients information companies use polls. However it is necessary to develop more sophisticated on line polling systems in which the specific profile of each survey respondent would be taken into account to aggregate the results.

Another effective way to gather information is to extract the knowledge from corporate databases or from the Web 2.0 communities, such as Internet forums, groups of bloggers, social network services, etc, which provides a platform in which users can collectively contribute and also generate massive content. Such an enormous amount of data it is widely known as 'Big Data'. One of the most straightforward manners of taking advantage of Big Data, is by creating transparency, that is, organizing raw data in such a way that making them more accessible and easy to understand in a timely manner. For example, by clustering similar objects, by showing the evolution of certain features along the time, or even by identifying possible trends. Properly understanding entire datasets could also lead to substantially improve the decision making process [19]. To do that, new ways of organizing and extract knowledge from Big Data need to be developed. These tools would provide the experts with a high level insight about a huge entire dataset helping them to make the most appropriate decision minimizing the risks.

5 Conclusions

We have analysed how the Web 2.0 tools can be used to improve cooperation and social decision making in the enterprise context. We have presented the most popular Web 2.0 technologies and shown their application in enterprise domains. We have also analysed the concept of Enterprise 2.0, discussing its characteristics. We have explained which are the main social tools specially designed to support the Enterprise 2.0. Finally, some current trends, open questions and prospects in the topic have been pointed out.

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