Wikis in enterprise settings: A survey

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Abstract: The wiki technology is increasingly being used in corporate environments to facilitate a broad range of tasks. This survey examines the use of wikis on a variety of organizational tasks that include the codification of explicit and tacit organizational knowledge and the formulation of corporate communities of practice, as well as more specific processes such as the collaborative information systems development, the interactions of the enterprise with third parties, management activities and organizational response in crisis situations. For each one of the aforementioned corporate functions, the study examines the findings of related research literature to highlight the advantages and concerns raised by the wiki usage and to identify specific solutions addressing them. Finally, based on the above findings, the study discusses various aspects of the wiki usage in the enterprise and identifies trends and future research directions on the field.

Keywords: Enterprise wikis, corporate wikis, organizational knowledge, wiki research

1. INTRODUCTION

Today's businesses continuously seek efficient means of gaining sustainable competitive advantage and strengthening their position in the marketplace. In this context, corporate collaboration and the value it can gain the enterprise is increasingly considered to be a corporate asset and therefore its support is becoming a strategic priority for organizations.

To meet the aforementioned need, Web 2.0 technologies, with their ability to improve productivity, collaboration and innovation in a both efficient and cost-effective manner, are increasingly being adopted by enterprises. The wiki technology, which allows users to collaboratively create online content in a flexible and simple manner, is among those Web 2.0 technologies that have attracted a significant amount of interest, a fact which is indicated by their growing uptake by a considerable number of organizations, in a variety of corporate settings.

Although the use of wikis has been discussed and summarized in the context of various domains, such as education (Kumar, 2009, Mohamad Nordin and Klobas, 2010), research and scientific collaboration (Sauer *et al.*, 2005, Giles, 2007) and the public sector (Noveck, 2009a, Noveck, 2009b, Bronk and Smith, 2010), little has been done in reviewing and synthesizing research literature on the use of wikis in corporate

contexts. Developing such a review is expected to be especially useful to a broad spectrum of audiences. These include managers, who seek effective means of implementing the wiki technology within their firms, employees, who need to use a wiki as part of their work description and therefore wish to be informed regarding the value it can add to their work and also scholars, who wish to become familiar with the work on the field and discover potential future research directions.

To address the above, this survey aims at exploring the use, effects and potentials of the wiki technology on the corporate sector and also at providing a comprehensive overview of the literature on the subject. In this context, a detailed analysis of both theoretical and real-world studies is performed and the impact that wikis have on a variety of different organizational processes is examined. Complementary to highlighting process-specific problems and solutions of the wiki usage, the present study also targets at identifying trends and future directions of research on the field of using wikis inside a corporate environment.

The rest of this paper is organized as follows: section 2 provides a brief introduction to the wiki technology in order to acquaint the reader with their most important characteristics. In addition, this section provides a definition of the main taxonomies and categorization schemes of the study, its levels of analysis and the boundaries of its scope. Section 3 formulates the main body of the review, analyzing the use and impact of wikis in supporting the needs of the various organizational processes. Section 4 provides a categorization and analysis of the various wiki platforms examined throughout the literature, focusing on the characteristics that each one supports, in parallel to the features needed by each organizational process. Section 5 provides a discussion over a number of aspects related to the use of wikis in enterprise settings and identifies certain trends and future research directions. Finally, section 6 concludes with the main findings of this work.

2. THE WIKI TECHNOLOGY

2.1 Historical Review and Description

The appearance of the first wiki system is placed in the mid-90's when Ward Cunningham created the WIkiWikiWeb platform to address the needs of a group of programmers. The term "wiki" was then used by Cunningham as an alternative to "quick web". It refers to a web site that enables the creation and publishing of interlinked web pages through the collaborative efforts of a group of web users. This

collaborative content creation is achieved in a remote manner, through a web browser and by using either the syntax of a simple mark-up language or through a WYSIWYG (What You See Is What You Get) text editor. A script then is typically invoked to store the resulting content on a database management system or on the file system of the web server that hosts the wiki.

A wiki platform offers two main usage patterns: the read mode, through which the wiki content is presented in the form of simple web pages to the users and the editing mode, through which users can edit, change or even delete the wiki content. This open editing feature and the simplicity that the wiki technology presents have made it establish a unique philosophy regarding knowledge sharing (Louridas, 2006). That is, unlike other web 2.0 technologies, like blogs, which tend to focus on broadcasting the personal opinions of one or more individual users, wikis focus more on consensus and on the collaborative building of common understanding and contexts. As such, wikis offer significant potential for knowledge sharing and collaborative endeavours inside the enterprise (Ramos and Piper, 2006, O'Leary, 2008).

2.2 Attributes of the Wiki Technology

The wiki technology is characterized by a number of attributes such as the interlinking feature, by which the wiki pages are connected to each other through hyperlinks, the edit feature, that allows users to contribute content and the preview feature, through which a wiki page can be previewed prior to its publication and storage. A number of other features related to various aspects of the corporate wiki functionality, such as syntax, structure, security, visualization personalization and others, can be found in the literature. Table 1 summarizes the main attributes of the wiki technology found in the examined literature, categorized according to the type of functionality that they offer and accompanied by their respective description. To enable referencing by other categorizations and tables of the study, an identification number has been assigned to each feature.

Table 1. Main features of the wiki platforms

Feature category	ID	Wiki feature	Description
1. Basic	1a	Version handling	Feature to enable handling of the changes performed among page versions. Includes version tracking and version comparison.

	1b	Discussion	Feature to enable discussions among the wiki users. May include flat (comments) or threaded discussion (forums) formats.
	1c	Multilanguage support	Feature that offers support in various languages.
2. Syntax – Formatting	2a	Basic text formatting editor	Simple editor that formats text based on the wiki syntax.
	2b	WYSIWYG editor	Rich text editor that supports the WYSIWYG (what you see is what you get) functionality.
	2c	Wiki syntax to HTML	Script to automatically transform text written according to wiki syntax to HTML format.
3. Structure	3a	Taxonomy	Categorization of the wiki content based on a taxonomy.
	3b	Folksonomy	Feature that allows users to add categorization tags on the wiki content.
	3c	Ontology	Feature that uses an ontology to add structure to the wiki content.
	3d	Document structure editor	Feature that allows wiki users to collaboratively edit the structure of the wiki content.
	3e	Automatic ontology extraction	Feature that automatically extracts the ontology of the wiki content based on a set of naming conventions that the wiki pages follow.
4. Search – Navigation	4a	Full text search	Search throughout the wiki content (title and content of the wiki pages).
	4b	Tag supported navigation	Navigation based on the tags placed on the wiki content.
	4c	Semantic querying	Semantic search and reasoning facility.
5. Security	5a	Access permission levels	Feature providing support of different access levels to the wiki user groups.
	5b	LDAP authentication	LDAP password protection.
	5c	IP address filtering	Use of a scope of valid IP addresses to permit access to the wiki.
	5d	Captchas	Feature to prevent bots from infiltrating the wiki.
6. Visualization	6a	User activity	Feature providing visualization of the user activity and whereabouts.
	6b	Comment visualization	Feature providing visualization of the user comments.
	6c	Workflow depiction	Feature providing visualization of the workflow of the business procedures stored in the wiki.
	6d	Source code highlighting	Feature allowing the highlighting of specific parts of the source code inserted as content in the wiki.
7. Personalization	7a	Personalized views of the system	Feature to allow personalized views of the system through different templates /skins.
	7b	personal user pages	Users are allowed to create their own pages inside the wiki system.
8. Complex document support	8a	SAP business objects	Feature to allow handling of SAP business objects.
	8b	Open Office documents	Feature to allow handling of Open Office or similar commercially licensed documents.
	8c	Tables	Feature to allow handling of tables inside the wiki.
	8d	Bibliographic references	Feature to allow management of bibliographic references.
	8e	Narrative experience recording	Feature to allow the recording of user experiences in formats other than text (audio, video e.t.c).
9. Computing capabilities	9a	Algorithm support	Feature to allow the use of algorithms (e.g. Monte Carlo, forecasting, optimization, decision tree analysis).
	9b	Business queries	Feature to formation of business queries (e.g. on SAP models).

	9c	Source code management	Feature to allow the handling (e.g. compiling, executing, debugging) of the stored source code/scripts.
	9d	IDE integration	Integration of wiki functionality to the IDE of the developer.
	9e	Web services support	Feature to allow the customization of the wiki content, in order to utilize capabilities offered by other web sites (such as Digg, Flickr, Windows Live e.t.c.).
	9f	Real-time tracking	Feature to allow real-time recording of user activity (e.g. web-based procedural actions).
10. Special pages	10a	Sandbox	A wiki page intended to allow users practice on the wiki editing.
	10b	Term glossary	A wiki page containing a glossary of terms used by the wiki content.
	10c	Help pages	One or more wiki pages dedicated to offering technical guidance on the use of the wiki platform.
		Questionnaires	
11. Other	11a	Notification mechanism	Mechanism (e.g. RSS, e-mail) to notify users regarding content changes that have occurred.
	11b	Multi-page handling	Feature to allow handling (e.g. add/replace text) of several pages at once.
	11c	Automatic permanent link transformation	Feature to allow the automatic transformation of certain wiki links to permanent links.
	11d	Content rating	Feature to allow users to rate the content.
	11f	Cross-page versioning	Feature to allow versioning among multiple pages.
	11g	Conflict detection or/and resolution	Feature that enables the detection or/and the resolution of conflicts (for instance the concurrent modification of the same page) - e.g. through page locking.
	11h	Ticket system	Feature to allow page handling through the use of tickets.

2.3 Literature Classification

Since the main focus of this survey is to examine the way that wikis are used in enterprise settings, the basic classification schema used refers to categorizing relevant research literature according to the organizational functions that each study belongs to.

Under this light, one may distinguish six main organizational processes (Table 2). These firstly include knowledge codification, i.e. the use of wikis for building and organizing the explicit and tacit organizational knowledge that exists in various parts of the corporation. The next process identified refers to the facilitation of the collaboration among more loosely connected, self-managed and informal units inside the organization, that is communities of practice. Apart from the above, four additional processes, which focus on more specialized business activities, can be found in the literature. Specifically, a field in which wikis are increasingly being used is interaction with third parties, i.e. the way that wikis are implemented – as help desks, advertising facilitators or as participatory publication means – to enhance the communication with corporate customers, suppliers and partners . Another process that can be identified refers to wiki-based information systems development and maintenance, i.e. the enhancement of various information systems processes – such as

information systems documentation, end-user programming, requirements elicitation and software reuse – through the implementation of wikis. Management activities – including decision making, project planning and managerial experience sharing – are also supported by wiki technologies, according to the literature. A final process in which wikis are used refers to organizational response in crisis situations.

The aforementioned organizational processes and the way that wikis are used in the context of each one of them are presented in section 3. In addition, a table summarizing the identified advantages and concerns of the wiki usage is provided at the end of each organizational task, followed by the main solutions proposed by the related literature studies. This table is intended to be used as a quick reference for readers that wish to acquire an overview of the wiki impact on that specific process.

Table 2. Literature classification according to the organizational process on which it focuses

Organizational process	**Sub-process**
Knowledge codification	Knowledge codification in large organizations
	Knowledge codification in small and medium organizations
Communities of practice	
Interaction with third parties	Help desk wikis
	Marketing and advertising
	Participatory publications
Information systems development and maintenance	Information systems documentation
	Software reuse
	Requirements engineering
	Collaborative end-user programming
Management activities	Decision making
	Project planning and organizing
	Managerial experience sharing
Organizational response in crisis situations	

3. WIKIS IN ENTERPRISE SETTINGS

This section – formulating the main body of the present survey – analyzes the effects, advantages and concerns that the wiki technology presents when used in the context of each one of the organizational processes illustrated above in Table 2.

3.1 Wikis for managing corporate knowledge

Without access to reliable and complete knowledge an organisation has limited ability to make the optimal decisions and reach to successful outcomes. This sub-

section presents the contribution of wikis in two major corporate knowledge management issues: knowledge codification and knowledge personalization. Knowledge codification denotes the gathering and organising of tacit and explicit knowledge that lies fragmented in various resources of the organisation. Knowledge personalization, as a means of developing human networks like communities of practice materializes by disseminating and sharing organizational knowledge, through communication & cooperation processes that take place while performing practical business tasks.

3.1.1 Knowledge Codification

One of the most popular tasks for which wikis are used inside a corporate environment is knowledge codification and management. As the literature reveals (Nonaka and Takeuchi, 1995, Jianyuan and Jin, 2005), knowledge inside an organization can be divided into explicit and tacit. Explicit knowledge, such as business reports and formalized corporate documents, is expressed through formal linguistic means and often involves the focused collaboration of distributed virtual teams s (Hupfer *et al.*, 2005) towards the development of such a deliverable.

Tacit knowledge on the other hand, represents the implicit knowledge and experience accumulated by organizational members over the years. This latter type of knowledge is more difficult to be formally described, yet its effective gathering also provides the organization with strong competitive advantage in the global marketplace (Hasan and Pfaff, 2006).

In this context, the wiki technology is increasingly being used, in a variety of different corporate settings, as a means of eliciting both explicit and tacit knowledge, as well as a means of facilitating its diffusion among corporate users (Hu *et al.*, 2007, Schulz, 2009). The advantages that this technology offers over other solutions typically used by organizations, to perform their knowledge codification processes, are many. Compared to static HTML intranet solutions (Hilska, 2008) – which often suffer from a closed editing nature and a strict hierarchical folder structure – relational databases, groupware and a number of CMS systems – which may not fulfill requirements such as querying and entering data in a flexible manner, wikis present the advantage of flexibility and user-friendliness (Happel et al., 2007, Alquier et al., 2009). In parallel, compared to more specific applications, such as product lifetime management platforms, the use of which often requires specific skills and is typically

restricted to a few individuals (Cammarata, 2007, Hoimyr and Jones, 2007), wikis present the advantage of simplicity and openness. Wikis can also effectively help overcome the version confusion and coordination difficulties often involved in more simple knowledge exchange processes, for instance the ones performed through e-mail communication or personal contact - by proving to be significantly useful in terms of version control, user recording, discussion facilitation, navigation enhancing ,attachment load reduction (Wiebrands, 2006, Hilska, 2008), as well as in terms of saving productive time, especially for expert employees (Leshed et al., 2008). Despite its advantages, the wiki usage in knowledge codification also presents the drawbacks of limited structural support and privacy concerns, mainly due to its collaborative nature. As a result of the advantages that wikis can offer the organization, but also taking into account the downsides, the wiki technology is being examined – either as a standalone application or complementarily to organizational existing solutions – by a number of corporations, which aim to enhance their in-house knowledge codification procedures and facilitate the collaboration among their team members.

3.1.1.1 Wiki-based knowledge codification in Large Organizations

A number of studies explore the use of wikis in large organizations. As the literature reveals, prior to implementing a wiki, such organizations have often already used another knowledge codification solution, which however did not produce the desired results. Overall, it seems that wikis can help towards this direction by augmenting the knowledge codification activities that need to be performed. Through the descriptions of organizational experiences, the literature also allows us to determine the main factors that seem to affect the success of a wiki in large corporate environments. These include the level of familiarization of the employees with the tool, the level of management support towards this new technology, the extent to which privacy concerns have been adequately addressed and the level of integration of the tool to the existing knowledge codification procedures of the organization.

Employee familiarization is one of the most critical factors affecting the success of the newly adopted, by the organization, technology, as reported by all the studies in this sub-field. The study of Hasan et al. (Helen Hasan *et al.*, 2007) - exploring the viewpoints of the employees of a large manufacturing company towards the wiki-based knowledge repository of the corporation - reveals that an easy-to-use wiki tool is a major prerequisite in order to enable the employees to become quickly

familiarized with this technology and thus effectively share their expertise. In fact unfamiliarity with the corporate wiki platform can not only significantly impede wiki adoption, but it can also lower the quality of the gathered tacit knowledge, often resulting to accidental deletions or distortions of other employee contributions (Leshed *et al.*, 2008).

Employee familiarization with the wiki technology can be achieved through various means. The first is to provide users with adequate training and time to be familiarized with the platform. An example of successful implementation of a corporate wiki platform, through extensive training is reported in (Hilska, 2008). This study explores the effects of a wiki substituting a former static HTML-page intranet solution, used by the National Public Health Institute, a governmental health sector research organization seated in Finland. Prior to launching the wiki, the organization familiarized the employees with its use through a series of workshops, while the training support continued after launching the tool through published user guidelines, help pages and a training area inside the platform where users could practice wiki editing . Interviews, conducted after a one-year pilot operation period, revealed that the majority of the employees were more satisfied with the use of the wiki compared to the former intranet solution, while they also found that the wiki significantly improved internal corporate communications and tacit knowledge sharing.

Another means of employee familiarization is selecting a user-friendly tool that will facilitate content retrieval and contribution. To this end, the study of Alquier et al. (Alquier *et al.*, 2009) propose customizing the wiki platform with a number of extra facilities and benefiting from the advantages of the semantic technology. Their study describes the experience of the Informatics department of a large pharmaceutical research organization in implementing an extended version of the semantic MediaWiki platform, namely KnowIT, to replace the relational database, formerly used by the organization. To support user familiarization, a number of extra facilities were implemented, including the development of a more simplified, user-friendly interface – compared to the typical MediaWiki platform – and the improvement of navigation and search through multiple semantic properties and the use of the RDF schema. Finally, the wiki pages were organized in three main categories, namely Search, Explore and Contribute, in order to further improve navigation and to provide users with a clear view of what they can do inside the system. The result was a more flexible and yet structured content management

system, which – after a one-year implementation period – was attested to facilitate employee access and expertise sharing.

The second main factor affecting the success level of a corporate wiki inside a large organization refers to management support. Active support from the management is considered to be one of the milestones in the wiki effectiveness; if the management is doubtful regarding the benefits of the tool, employees are less likely to use it. Support can be provided through specific incentives for contribution, which may be tangible or not. In addition, since contributing to the wiki is a time-consuming task, it is crucial that the management considers the contribution efforts of the employees to be part of their work description and not as an extra activity (Helen Hasan *et al.*, 2007). The management should also support the establishment of a wiki culture inside the organization, through actively urging employees to incorporate the wiki into their everyday communication routine – together with e-mail (other or existing?) communications – and to develop a common writing culture and wiki-centred habits – such as marking pages as favourites and subscribing to e-mail alerts. Finally, it is also important to realize that this change in the cultural traits of the organization is a transportation process that can take over a year to accomplish (Hilska, 2008).

A third important success factor refers to the level that the potential confidentiality issues raised from the open nature of the wiki have been met (Helen Hasan *et al.*, 2007). Special attention should be paid on this factor in case that the wiki incorporates additional monitoring facilities. An indicative case of a corporate wiki - implemented inside a large organization – that was not satisfactorily adopted by the employees partially due to privacy concerns, is described by Leshed et al. (Leshed *et al.*, 2008). The implemented system, namely CoScripter, incorporates a browser plug-in to record the web-based procedural tasks accomplished by the employees and then stores this information as human-readable scripts in a wiki. In this way it serves as a tacit knowledge sharing system that provides corporate members with valuable guidance regarding best practices on specific organizational tasks. However after a ten-month implementation period the participation was low and one of the main reasons for this was privacy, since the employees felt that there was a risk of personal information disclosure through the scripts that one shared in the wiki. In addition, the insufficient addressing of the privacy concern did not enable the gathering of the

necessary critical mass of participating users and thus further dissuaded employees to contribute.

Another important aspect affecting the success of a corporate wiki inside a large-scale organizational setting refers to the level of the integration of the tool to the existing knowledge codification processes of the corporation. For instance, the use of the wiki only in a small part of the organization, such as a single department, may cause communication difficulties due to the differences in the knowledge codification formats used. This issue can be amended by enabling the export of the wiki content to other formats, such as PDF, commonly used throughout the departments of the organization (Wiebrands, 2006).

An approach which is also beneficial towards integrating the wiki platform to the existing codification norms of the enterprise is using the platform complementarily to other technological solutions, already implemented within the organization. An indicative successful case of this type is the one described in (Cammarata, 2007 , Hoimyr and Jones, 2007), where TWiki was used at a large-scale, research oriented organization, namely CERN. Specifically, the wiki was implemented to facilitate the project documentation needs of the various CERN departments, which host large numbers of collaborating teams, often from heterogeneous fields of expertise. After an early adoption phase, which lasted two years, the wiki was centrally adopted and used complementarily to the traditional document management processes of CERN, by creating links between the documents stored in the wiki and other project data, such as engineering specifications, drawings and CAD-models. The reported outcomes regarding the wiki usage at a specific very large-scale engineering project (ATLAS) were impressive. Statistical results from a one-year period of usage showed a dramatic increase in the number of topics published, while the monthly topic views reached 1.8M and the wiki collected over 27,000 topics and more than 2000 active users. In addition, the wiki was acknowledged to improve communication, collaboration and knowledge sharing, it increased one's autonomy in retrieving useful information, while its use was easy and did not require the extensive training level of the previous documentation methods. From an administrative point of view the wiki was found to improve three main aspects inside CERN, namely speed, collaboration and sharing. It should be noted here however that this positive effect was supported by the already existent open

culture of the organization, since CERN is an organization welcoming and producing innovation.

3.1.1.2 Wiki-based knowledge codification in Small and Medium Organizations

The efficient codification of organizational knowledge is an aim not only of large but also of small and medium enterprises (SMEs). The different philosophy present in the latter organizational environments seems also to affect the use of wikis inside them. For instance, it is often for SMEs to undertake projects that typically do not last long, but their employees are likely to be involved in similar projects, a fact which renders the effective codification and reuse of knowledge in these organizations even more a necessity (Feng *et al.*, 2007). In addition, the personal element is stronger in small and medium enterprises, with the employees likely to know each other and to be hierarchically closer to the management than it is the case in large corporations.

Four indicative case studies of implementing a wiki for the purposes of knowledge codification in small and medium enterprises are presented in by Feng et al. (Feng *et al.*, 2007), Munson et al. (Munson, 2008), Stenmark (Stenmark, 2005) and Wiebrands (Wiebrands, 2006) . The first study refers to the successful application of a wiki platform in the IBM Club of Harbin Institute of Technology (HIT), where the wiki served as a knowledge repository for the projects that the members of the club were involved in. Results of this wiki usage indicated that the wiki enabled the gathering of project-related information, which could later be used as training material, while in parallel, the improved communication collaboration efficiency achieved through its use significantly enhanced the overall competitiveness of the organization. The second study is based on the deployment of MediaWiki at Playloads Studio, a department of the Boeing enterprise, dedicated to the exploration of advanced concepts in the field of future commercial aircraft interiors. The results were similar in this case too, since the wiki increased user participation and enhanced the outcomes of the employee collaboration. The third study reports on the employees' viewpoints regarding the launch of a wiki platform, namely UseModWiki, as an intranet solution for the needs of a small IT company, namely Citic. Citic is a knowledge intensive small organization consisting of 24 employees, while its organizational structure is very flat, with one general manager and a high degree of autonomy among the employees. The wiki usage in this case was also attested

successful, with the employees reporting that it provided them with the ability to update and share information in an easy, less time consuming manner and with the corporation migrating all relevant content to the new system after 6 months of usage. Finally, the fourth case study (Wiebrands, 2006), held by the research services unit team, part of the Library and Information Service at Curtin University of Technology, reports that the implementation of a wiki platform, namely MediaWiki, helped the team enhance its co-authoring and communication activities, while it also enhanced the quality of the produced business documents.

A number of interesting issues regarding the use of wikis in the environment of a small and medium enterprise can be revealed through the above case studies.

Firstly, wikis generally seem to produce better results than other solutions previously implemented by enterprises, as far as user motivation is concerned (Hu *et al.*, 2007). For instance in the case of HIT, prior to using a wiki, the Club used a bulletin board system (BBS) to exchange experiential information, a solution however which resulted in difficulties in retrieving useful information and in lowered participation. In the cases of Playloads Studio and Citic, information sharing was performed in a centralized manner, by a person assigned with the task of receiving the knowledge contributions of the employees and subsequently updating the corporate content. This solution however rendered content updating a laborious task and led the employees to use other methods, such as e-mail exchanges for their knowledge sharing needs. In all three cases the shift from the previously implemented approach to the collaborative-editing philosophy of the wiki enhanced team spirit and resulted to increased participation levels, since the employees felt more involved in the information sharing processes of the organization and therefore they were more motivated to contribute. Another interesting issue, pertaining to user motivation, is that the personal element present in small and medium enterprise environments can significantly facilitate the gathering of tacit knowledge, since in such environments the employees are more willing to share their experience, compared to sharing one's knowledge with total strangers, as would be the case in large enterprises (Feng *et al.*, 2007). Finally, providing the appropriate rewards is also suggested as a further means of enhancing motivation. These rewards are not limited to material compensations but they are also extended to social acknowledge and self-worth establishment (Hu *et al.*, 2007). For instance, in case authorship recognition is provided through the corporate wiki platform, the employees develop a personal reputation, through their

contributions, gaining value from their co-workers, a factor which can increase their incentive to participate (Munson, 2008).

A second issue, suggested by the aforementioned studies, is that wikis are especially suitable for small and medium enterprises, since the open source nature of a variety of wiki platforms makes them a more cost-efficient solution and therefore more appealing to the budget capabilities of SMEs, compared to commercial knowledge management systems.

3.1.1.3. Additional wiki-related knowledge codification issues

A number of interesting issues – regarding wiki-based knowledge codification – mentioned in the literature concern both large and small and medium enterprises. These issues pertain to the need for ensuring the quality and the organization of the stored information, to the need to handle more complex, than simple textual, document types, as well as to the need of providing the collaborating corporate members with workspace awareness within the wiki platform.

Information quality concerns are pointed out by almost all the studies in the related literature of this section. The main solution proposed refers to the assignment of the content maintenance to a group of individuals, referred to as "data curators" or "wiki gardeners", who will act complementarily to the wiki contributors, monitoring the inserted content, marking it with quality tags and enhancing it if necessary (Cammarata, 2007 , Hoimyr and Jones, 2007, Alquier *et al.*, 2009).

Another major concern expressed, refers to the potential chaos in the organization of the stored information, due to the openness of the wiki approach. Apart from the use of a dedicated group of wiki gardeners, other solutions proposed to resolve the aforementioned issue include clearly defining the scope of the wiki and enforcing some content structure. That is, although the predefined structure enforced by other, more static solutions is not suitable for the requirements of the corporation, yet the innate lack of structure of wikis can also be a major barrier. Therefore, a middle ground solution, benefiting from both approaches, is suggested to allow users locate the information that interests them, as well as to avoid contribution duplications (Stenmark, 2005, Munson, 2008).

An additional wiki feature especially useful as far as explicit knowledge codification is concerned, refers to the handling of more complex, than mainly text-based, document types. That is, virtual corporate teams collaborating towards the

development of a specific business document, often need to use more complex documents, such as spreadsheets and references, to maintain and organize organizational data.

In particular, the concurrent modification of the same table is critical in team collaboration cases, which involve work on tabular data. This process is typically performed by accessing the tables sequentially and then distributing the data through e-mail. For this kind of work, Zheng et al. (Zheng *et al.*, 2007) propose WikiTable, a platform based on the AJAX technology, which allows multiple users to simultaneously work on the same table. To achieve this, each table is materialized as a collection of separate, independently modifiable cells. Initial outcomes of the implementation of WikiTable on a large collaboration project, involving six teams from Siemens Corporate Research, resolved challenging issues such as the coordination and editing of tabular data among multiple users, the querying of the tables and the export of their data to other applications.

Bibliographic references is another type of data, not typically handled by wiki platforms but necessary for the effective collaboration of teams engaged in the co-authoring of specific documents, such as scientific articles. To this end, Regolini et al. (Regolini *et al.*, 2008) present the experience of using a wiki-based bibliography environment for storing searchable references at the Cemagref research organization. The platform, namely Wikidnx, allows team members to share their bibliographic references, accompany them with full text attachments, export them in various formats, such as RIS, BibTex, RTF and PubMed, and comment upon the stored references contributed by other users. Wikidnx also integrates a word processor for the authoring of publication-ready articles and includes different levels of access permission, such as general, restricted or individual access rights. Prior to using the wiki platform, the references were stored at a centralized database, the maintenance of which was laborious and required assistance of specialized IT experts. The adoption of Wikidnx was therefore decided and performed after an initial period of presenting it to the employees through corporate meetings and seminars, as well as publicizing it through mailing lists and the intranet portal. Usage outcomes indicate that the wiki-based platform gained the team members valuable time in their daily work and resulted in more productive co-authoring of organizational documents. The aforementioned Wikidnx platform combines characteristics also found in other reference management systems (Wikipedia, 2011a), such as the collaborative

reference sharing feature offered by Mendeley (Mendeley, 2011) and BibSonomy (BibSonomy, 2011), or the word-processor intergration offered by Endnote (Thomson.Reuters, 2011). A differentiation, which may be observed, compared to the aforementioned systems, is the addition of the collaborative aspect also on the article writing procedure, i.e. instead of being integrated to the Office suite of the local computer of the user, Wikidnx supports a wiki-based and thus more collaborative-oriented article authoring process.

A final critical factor affecting corporate team performance, regarding knowledge codification, is workspace awareness. This means that to achieve high levels of effectiveness, it is important for team members to be aware of the work and the interactions of their collaborators with the shared team workspace, as well as of the ways that the collaborative work evolves over time. To improve workspace awareness during the document co-authoring process, Liccardi et al. (Liccardi *et al.*, 2007, Liccardi *et al.*, 2008) propose a wiki-based system that informs team members about the information that each user has contributed to a specific document, through a number of novel features. These include the adoption of multiple sections to form a complete document, instead of the multiple-page format of traditional wikis, the use of threaded discussions and forums to support communication, as well as the use of visualization techniques to inform users about the history of user actions and the tasks that other colleagues are involved. Other document-related activities such as task planning or deciding on the structure of the corporate document are also visually announced. In addition, the system supports comment visualization to inform users of each other's opinions and lead the team to consensus decisions. Finally, team members are able to have personalized views of the system to include only those elements that interest them.

Summarizing, as illustrated in Table 3, the potential of the wiki technology is increasingly being examined by both large and small and medium-sized organizations, as a means of collecting, codifying and maintaining corporate knowledge, as well as a means of effectively distributing this knowledge among the employees. Results of using the wikis technology indicate that it can be more efficient –in terms of cost and flexibility- compared to other knowledge codification solutions, while in parallel it can also help engage the organizational knowledge workers more into the sharing culture needed to contribute one's expertise (Hasan and Pfaff, 2006). Nevertheless, in order to become fully beneficial to the organization, certain issues

need to be attended. As far as large corporations are concerned, these issues include familiarizing the employees with the implemented wiki platform, ensuring active management support, addressing the potential confidentiality issues and integrating the platform to the existing knowledge codification norms of the enterprise. As far as SMEs are concerned, the main issue refers to motivating the employees to participate, through tangible or intangible rewards. Finally, quality assurance, content structure, complex document handling and workspace awareness provision are a number of issues, which should also be reinforced to facilitate wiki-based knowledge codification in both large and small and medium enterprises.

Table 3. Wikis in corporate knowledge codification activities: Advantages, concerns and proposed solutions

Sub-process	Knowledge codification in large organizations	Knowledge codification in SMEs
Target activity	Codify and disseminate organizational knowledge inside large organizational settings	Codify and disseminate organizational knowledge inside SME settings
Advantages	Can support organizational tacit knowledge management better than other, typically used content management solutions	▪ Wikis receive higher participation levels than other solutions due to: • Higher employee sense of involvement • Personal element present in SMEs ▪ Cost-efficient solution, appealing to the budget capabilities of SMEs
	▪ Need for: • Employee familiarization • Management support • Addressing potential privacy issues • Integration to existing organizational knowledge codification processes	▪ Need for: • Motivation boosting
	▪ Need for: • Quality assurance of the inserted content • Structural support • Complex document handling • Workspace awareness provision	
Proposed solutions	▪ Familiarize employees through: • Continuous training both prior and after wiki launch • Selecting a user-friendly tool ▪ Ensure management support through: • Provide incentives for participation • Recognize contribution efforts as part of the employees' work description • Actively support the establishment of a corporate wiki culture ▪ Ensure confidentiality of the employee data ▪ Achieve wiki integration through: • Enabling content export to common formats, such as PDF • Use complementarily to other technological solutions	▪ Enhance motivation to participate through: • Tangible or • Intangible rewards, such as authorship recognition

	▪ Assign quality monitoring to dedicated group of data curators ▪ Adopt a middle-ground solution regarding structure ▪ Augment the platform with complex document handling capabilities ▪ Include workspace awareness-enabling features (comment and activity visualization, communication support, notification mechanisms)

3.1.2. Communities of Practice

Apart from participating in work groups and other explicitly formed teams, the employees of an enterprise often benefit from the formulation of corporate communities of practice (CoPs). Defined by Wenger, et al. (Wenger *et al.*, 2002) , "Communities of practice are groups of people who share a concern, a set of problems, or a passion about a topic, and who deepen their knowledge and expertise in this area by interacting on an ongoing basis". This type of communities are different from normal business units because they focus on knowledge creation and they are loosely connected, self-managed and informal (Fægri *et al.*, 2005). They also differ from technical and specialist committees since they focus more on practical rather than on theoretical knowledge. Communities of practice are a different form of organization inside a company, compared to the normal division in departments or projects. Through communities of practice, the employees can benefit from larger networks of informal knowledge sharing, a fact which is expected to have positive effects on the whole organization. Unlike purely functional teams, communities of practice emphasize on what and how people learn from each other rather than on who they report to. Learning in communities of practice is thus realized not as a process of individual knowledge acquisition, but rather as a social participation process, namely legitimate peripheral participation, in which the community members learn through their involvement to tasks that are gradually more central to the functioning of the community (Lave and Wenger, 1991). According to the results of a case-based study (Corso and Giacobbe, 2005) communities of practice inside an organization are not static but they evolve. The pace of their evolution depends on the commitment of the organization and the willingness of its members to participate.

There is growing evidence that community formations of this kind can be significantly enhanced through technological solutions that will provide both the virtual space in which the community will function and a record of the knowledge created (Johnson *et al.*, 2008). Technologies for communities of practice can be synchronous or asynchronous, group or individual-oriented and can accommodate a wide range of learning activities such as productive inquiries, knowledge exchanges,

building of shared understanding, producing assets, creating standards and formal access to knowledge. These technologies include mainly portals, online project and meeting spaces for synchronous interactions and team work, websites for community management, blogs for online discussions, e-learning platforms and document repositories (Wenger *et al.*, 2009). Each one of these technologies has to offer significant benefits to a community and probably more than one need to be selected in order to satisfy these needs. In this context, wikis are not to be seen as competitive to existing technologies but rather as a complementary technology that can be used in the effort of the organization to satisfy its specific business strategy regarding its in-house communities of practice. Indeed, the advantage that wikis present refers to their many capabilities for customization and integration with existing technologies in order to cater for most of the aforementioned learning activities that take place within communities of practice. In addition, as a number of studies reveal, wikis can serve as a knowledge and communication platform for a virtual corporate community of practice, the members of which can publish their objectives, share their knowledge with the group, put up interesting pieces of information, work together on particular subjects of interest, discuss issues and so on (Schaffert *et al.*, 2006, Mestad *et al.*, 2007) .

The successful implementation of a wiki to support the requirements of a corporate community of practice has various potential affordances, as Johnson et al. (Johnson *et al.*, 2008) suggest. Their study describes the technology and the rationale for using a commercial enterprise wiki software tool, namely Confluence, to meet the needs of a developing research community of practice at the University of Wollongong. The authors argue that universities, being text book cases of large enterprises from the perspective of IT infrastructure, may not rely on traditional open source wiki systems, due to the limitations that the latter present on the issues of providing technical support, supporting multiple teams and projects, supporting rich content and integrating well with other applications. The authors suggest that enterprise wiki systems for CoPs need to include additional features such as multiple user support, “fine-grained” user permissions that will ensure content confidentiality, the ability to access different information sources from a range of vendors, web service support and enhanced discussion mechanisms to facilitate communication. The main advantages of using the aforementioned wiki platform include enhanced problem-solving and brainstorming activities through the online editing of

collaborative pages, as well as the successful handling of requests for information owing to the ability to access various types of information repositories. The authors also point out that using a wiki specialized on the needs of the enterprise, is expected to facilitate coordination by making available automatic mechanisms that inform users about content changes.

Apart from the requirements mentioned above, a number of studies indicate that wikis used by communities of practice need to effectively address issues pertaining to structural support and integration to the formal workflows of the organization, as well as specific issues related to the formation of communities of practice among different organizations.

As far as content structure is concerned, a number of studies indicate that besides assigning the maintenance of the information organization to specific groups of individuals, semantic wikis can also be used as a potential solution. As an example, Ghali et al. (Ghali *et al.*, 2007) present the results of using Sweetwiki, a semantic wiki, in the context of Pallete, a project for the support of CoPs. Along with common wiki features, Sweetwiki makes use of an ontology, modifiable by the wiki developers, to enhance navigation through the content. Additional features include social tagging, performed through the use of a folksonomy and modifiable by the wiki users, tag supported navigation, semantic querying and enhanced awareness over the changes made to the wiki pages. Initial results on the use of SweetWiki by a CoP comprising a thirteen-member research team at the Liege University, indicate a number of interesting possibilities, mainly regarding the capability of sharing and collaboratively building annotated knowledge, which can be re-organized at any time, to suit the needs of the CoP. Similarly to the above, other semantic wikis, such as IkeWiki (Schaffert, 2006) and Platypus (Campanini *et al.*, 2004), are also reported in the literature to support the work of corporate communities of practice, with possible usage scenarios that include ontology engineering, knowledge management through metadata usage and collaborative learning.

The knowledge created through CoPs is often dynamically and non-linearly created. Yet, in order to be mostly useful for the organization it needs to be effectively incorporated into the formal corporate workflows and work processes. A number of studies (Fuchs-Kittowski and Kohler, 2005, Dello *et al.*, 2008) propose using wikis to facilitate the connection of the linear and formally described work processes of an organization with the ad-hoc knowledge created in the context of these processes

through the organizational communities of practice. These studies point out that especially as far as corporate wiki environments are concerned, it is important to follow specific workflows during the collaborative editing of a wiki article. For instance, a certain department should provide its input before another department takes over the work in the wiki. To address this issue, both prototypes developed by the aforementioned studies offer functionalities such as modelling of all the work processes as workflows, linking every step of the process to a repository of related knowledge, enabling the creation or updating of a new wiki page for every step of the process and providing content-related search inside the wiki.

Communities of practice are also often formed inter-organizationally. The positive and negative experiences reported by the literature regarding the use of wikis to support this type of CoPs point out that a number of specialized issues need to be taken into consideration.

Specifically, the collaboration among CoPs that include members from different organizations necessitates the familiarization of the people involved with the processes and procedures, language, documents, terminology, and acronyms used by other organizations. Wikis can prove helpful towards this direction, especially if they are integrated with other synchronous and asynchronous communicating tools such as knowledge databases, personal space and group use lists (Nuschke and Jiang, 2007). Training is also significant, as suggested in (Lio *et al.*, 2005). This study describes the use of TWiki to support a CoP, consisting of teachers from different organizations and school orders, in sharing professional expertise, best practices and collaboratively develop new teaching material. TWiki was chosen due to its openness, easy customization and non proprietary technology. Results of the wiki usage indicated that despite the initial reluctance, TWiki was positively viewed by the participants, mainly due to the familiarization of the users with the platform, prior to its launch, through four training sessions.

The social aspects of using the wiki platform can also significantly affect its acceptance by the members of the inter-organizational CoP. For example, the aforementioned study indicates that the fear of criticism, the reluctance of giving up ownership and the lack of support by headmasters and fellows hindered the acceptance of the wiki. Not properly addressed social-related factors also played an important part in the failure of a wiki platform to support knowledge exchange among an inter-organizational CoP dealing with the improvement of public health issues in

London, a case described in (Giordano, 2007). In particular, the results of this study indicate that the perceived low payoff, due to the lack of social and authorship recognition, made the CoP members unwilling to share their knowledge. Matters of trust also appeared, since the CoP members were not certain on how the information they shared would be used, or whether its usage would benefit their own organization. An additional factor related to the wiki failure refers to the poor identification of the scope of the wiki, an issue which lead to uncertainty on the type of information that users should exchange. A final reason for the failure of the wiki platform was the lack of knowledge sharing motivation among the members of the different organizations, since the CoP members felt that their organizations were in competition with one another for funding, and this made them reluctant to share their knowledge. According to the aforementioned study, these issues can be resolved, if the participating organizations actively encourage knowledge exchange by integrating the wiki to the daily work of their employees instead of considering it an add-on to the existing work performed at individual organizational level.

Thus, it becomes clear that the success of virtual CoPs is a two-fold issue: firstly it relies on the use of the proper technological collaboration means, such as wikis, but it also requires the cultivation of support and trust among the CoP members. As the previous studies indicate, this not only leads to increased user participation, but it can also help towards achieving higher levels of information quality. As Neus suggests (Neus, 2001), further steps to ensure trust, commitment and interaction among the members of the CoP include ensuring accountability for one's contributions as a basis for their reputation, development of standards by the CoP regarding the quality expected from peer members, developing a sense of trust and identity through personal profile pages and having certain membership criteria to maintain the level of the exchanged information high and on-topic. Table 4 summarizes the main advantages, concerns and identified solutions of the wiki usage in corporate intra- and inter-organizational communities of practice.

Table 4. Wikis facilitating the activities of corporate communities of practice: Advantages, concerns and proposed solutions

Sub-process	Target activity	Advantages	Concerns	Proposed solutions

Intra-organizational CoP	▪ Publish common CoP focus and objectives ▪ Share knowledge with the group ▪ Work together on particular subjects of interest	▪ Communication and collaboration improvement ▪ No extensive training required ▪ Version control ability ▪ Low cost solution	▪ Need for structural support of the content ▪ Need for integration in the formal corporate workflows	▪ Use of semantic wikis ▪ Model the work processes inside the wiki as workflows, linking every step of the process to a repository of related knowledge
Inter-organizational CoP	▪ Exchange professional experience ▪ Share best practices		▪ Need for familiarization with the processes and culture of other organizations ▪ Low participation due to: • Social problems (Lack of management support, lack of knowledge sharing motivation due to competition for funding • Poor identification of the wiki scope	▪ Provide training to tackle with culture integration and familiarization issues ▪ Provide management support by: • Integrating the wiki to the daily routine of the employees • Recognizing the contribution efforts of the employees ▪ Clearly define the scope of the wiki

3.2 Wikis for supporting effective corporate governance

Wikis represent a rich social networking and collaboration solution to connect employees, customers, suppliers and partners and thus leverage the corporate experience and effectiveness. This sub-section examines the possible uses of wikis in various business functions, which contribute to the overall support of corporate governance tasks by improving organisational effectiveness. The tasks that can benefit from the use of wikis are both internal to the organisation – like the development and maintenance of information systems and corporate management activities – or external, like the interaction of the enterprise with third parties and the organisational response in crisis situations.

3.2.1 Information Systems Development and Maintenance

The development and maintenance of information systems is an organizational process that involves building a variety of information systems modules and allocating a significant number of tasks to different stakeholders and developers. The necessity for effective communication, coordination and co-creativity (Pallot *et al.*, 2006) among the distributed development teams (Decker *et al.*, 2007) can be accomplished, as a large number of researchers argue, through the use of wikis.

As the relevant literature reveals, there are four main categories regarding the use of wikis in information systems development and maintenance. At their simplest form wikis are used to facilitate the information system documentation process by providing developers with the ability to upload the developed source code and link it to documentation. Furthermore, wikis can be used to enable end user programming (Louridas, 2006) and to facilitate the elicitation of the requirements of a project related to information systems development. Finally, wikis can be implemented to assist the reuse of the developed information systems artefacts in similar projects that may arise within the corporate setting.

3.2.1.1 Information systems documentation

A first information systems development sub-task where wikis are widely recognized and used is the facilitation of documentation needs of the development process, with tasks such as defining the design specifications of the information system, developing testing plans and linking the source code to its supporting documents (Liang *et al.*, 2009) (Al-asmari and Yu, 2006) (Aguiar and David, 2005) (Chau and Maurer, 2004).

As the literature reveals, small and medium enterprises can use wikis as a means of entering the information systems development market more effectively. That is, contrary to large scale information systems developing organizations that can afford to fully adopt the experience factory concept – through for instance creating multiple developer teams, each assigned with specific documentation duties – SMEs must use other mechanisms to create their knowledge base and achieve similar results. To this end, various case studies (Chau and Maurer, 2005, Al-asmari and Yu, 2006) (Decker *et al.*, 2007) indicate that wiki platforms successfully served as lightweight knowledge repositories in small and medium sized information systems development companies, speeding up the documentation process, facilitating the communication between the developers and helping the latter self-coordinate towards achieving significant collaborative results. A number of other interesting issues were also revealed through the aforementioned studies. Firstly, it seems that as far as the documentation of the information systems development process is concerned, wiki platforms potentially need to provide developers with further personalized means of communication, like instant messaging or web conferencing. This remark is extracted from the contradicting observations made in the literature, i.e. while in one corporate

case the wiki reduced the communication load, i.e. e-mail or telephone usage, another study revealed the opposite, with developers preferring external means for their synchronous interactions. Another important issue revealed, is the need for corporate wikis to support the co-editing of more complex types of documents, such as Word or Excel files.

Apart from small and medium corporations, large-scale enterprises can also benefit from the use of wikis to support their information systems documentation processes. An indicative case study is the one performed in (Shepherd, 2008) regarding the successive implementation of two wiki platforms, namely MediaWiki and Deki, to support the information systems documentation needs of the Mozilla corporation. Prior to using a wiki the developer documentation was maintained in HTML pages, while the source code versions were controlled through the CVS versioning system. This approach however resulted in low participation levels, especially from users other than software engineers, since it required specialized knowledge skills, such as a full understanding of the HTML code. MediaWiki helped overcome the above limitations, through the features of easy access and integrated control that it offered. Thus, more effective documentation results and higher participation levels were achieved, with 500,000 page views per day and over 13,000 articles in thirteen languages. Nevertheless, during this two-year implementation, certain issues were raised, mainly regarding the inability of the platform to handle downloadable code samples, a fact which led developers to email their samples to an administrator instead. The Mindtouch Deki platform, used next, provided better support of the technical requirements of the documentation process and seemed to better suit the needs of this large-scale corporation. In particular, in contrast to the embedded features of MediaWiki, Deki could be more easily customized to include certain extra facilities required, while its integrated multilanguage support enabled contributors to perform more effective searches without having to cross-link between localizations. Although it allowed contributors to collaborate more effectively than ever before, certain issues regarding the use of a wiki in documenting a large information systems project, were also raised. These include security concerns, potential inaccurate content, due to the contributions of not adequately knowledgeable users, and conflicts among contributors regarding different writing styles and agendas.

3.2.1.2 Software Reuse

Apart from documentation, another important aspect of the information systems development process is software reuse, i.e. using existing source code samples and information to serve the needs of similar future projects (Rech *et al.*, 2007). This process is especially challenging for small and medium-sized information systems developing enterprises, which cannot afford the tools and expert staff typically required, and may thus suffer the costs and time delays of "reinventing the wheel". As the relevant research literature reveals, wikis can prove to be a valuable and affordable solution towards this direction.

The most important aspect of a successful software reuse process refers to the easy content retrieval. To this end, various studies focus on facilitating search inside a wiki platform through the use of various semantic capabilities. As an example Rech and Bogner (Rech *et al.*, 2007) report on the successful implementation of Riki, a reuse-oriented wiki platform, in a collaborative project between two German small and medium enterprises, namely Empolis GmbH and Brainbot. Prior to the use of the wiki, information reuse for these corporations was a hard and demotivating task, since the relevant documents were stored in multiple sources and they were not linked to one another, therefore forcing users to manually search for them to collect the necessary information. The use of case-based reasoning and ontologies, performed through Riki, was found to increase content reuse and enhance knowledge sharing. The study of Shiva and Shalla (Shiva and Shala, 2008) also suggests information retrieval facilitation through the use of personalized search capabilities, natural language processing techniques and the ability to add metadata to the stored software components. Instead of using explicitly pre-defined ontologies, Decker and Ras (Decker *et al.*, 2005) propose another means of enhancing content search and categorization, based on the use of a set of naming convention to title each wiki page. Through this approach the wiki documents can be automatically interrelated to the concepts they describe, thus leading to a self-organized content categorization, which facilitates software information reuse.

Apart from structure, an additional issue highlighted by the aforementioned studies refers to the need to ensure the quality of the content to be reused through the wiki platform. To this end, they propose strengthening the wiki platform with

automatic quality management capabilities, enabling users to filter and minimize non-qualitative knowledge through for instance the use of tags.

3.2.1.3 Requirements Engineering

Another process that is critical to the success of a information systems development project is requirements engineering and elicitation, that is, the definition of the conditions that the products of the project need to meet, taking into account the potentially conflicting requests of the involved stakeholders (Sommerville and Sawyer, 1997).

To this end, a process frequently used to satisfy the changing requirements of the involved parties is agile information systems development, through methodologies such as the scrum model. In contrast to more traditional methodologies like the waterfall model, in which the development process is performed in specific pre-defined phases, scrum is more flexible and allows potential changes in the requirements to be incorporated to the final product. Nevertheless, due to its nature scrum typically necessitates frequent meetings between the developers and the stakeholders, a condition which cannot always be satisfied. The experience of the 3M corporation, a large IT company, in using a wiki platform to benefit from the flexibility of the scrum model but to overcome the limitations that the inevitable lack of co-location brings on, is described in (Moore *et al.*, 2007). Prior to using the wiki the company conducted its scrum meetings through the Lotus Notes team rooms, a solution which however did not prove as interactive as needed. The benefits that the enterprise gained by integrating the wiki to its work processes include effective synchronization of the team of the developers, acceleration of the product completion and increased stakeholder interaction. The major drawback of the above implementation was the unwillingness of a number of stakeholders, to leave the traditional information systems development techniques, and to adopt the agile way of development.

Apart from the need to promptly respond to emerging stakeholder requirements, an information systems development process usually involves complying with the needs of stakeholders from different organizations, disciplines and locations.

The procedure of eliciting the requirements of various types of stakeholders in order to customize generic information systems products, such as ERP or CRM, to their individual needs is examined in (Silveira *et al.*, 2005) though the use of wiki-

based repository, namely XSDoc. Some interesting features implemented in the tool are the use of questionnaires and parameterizable templates to allow the definition of various configuration parameters and thus enable the necessary product customization. Another study that highlights the need to respond to different stakeholder requirements is the one by Wu and Yang (Yang *et al.*, 2008). This study points out that, in the rapidly changing global environment of modern businesses, software stakeholders from different disciplines often need to collaborate in order to negotiate information systems requirements and achieve mutually satisfactory outcomes. To this end, they propose WikiWinWin, a wiki-based platform based on Twiki, which is built on the theoretical basis of the win-win requirements negotiation approach, and provides stakeholders with the appropriate tools to achieve requirements that are satisfactory to all negotiating parts. The implementation of the aforementioned platform on 20 real- client information systems projects (Wu *et al.*, 2009) revealed that the wiki-based promotion of the win-win negotiation concept achieved successful results and enabled the information system stakeholders that actively used this method to elicit their requirements more efficiently compared to less participating teams. Specific attributes of the tool, which are reported by the study to help the requirements negotiation process, include the use of a predefined topic taxonomy to better categorize the requirements, the support of concurrent multi-project negotiation activities, as well as the technical guidance that it provided stakeholders with. A study that also describes the experience of using a wiki to elicit the requirements of distributed stakeholders from different organizations is the one performed by Decker et al. (Decker *et al.*, 2007). In this study, a platform based on MediaWiki, namely SOPwiki, was used to elicit the requirements of 12 stakeholders from 5 different organizations, who were assigned with the task of collaboratively designing the requirements architecture of a German information systems project, namely RISE. The use of SOPwiki in this case was so successful that a number of the industrial partners involved initiated information systems engineering wikis in their own organizations.

As the aforementioned studies reveal, wikis can be especially useful in facilitating the negotiation and elicitation of the requirements of an information systems project. Nevertheless, certain issues are also highlighted, including the need to provide stakeholders with comprehensive training on how the tools provided by the specific wiki platform are used, as well as the need to provide extensive support over

the versioning and searching capabilities offered. In this case too, the literature suggests enhancing the wiki platform used with semantic capabilities and further versioning support. For example the aforementioned study reports on extending SOPwiki with features for version tagging, cross-page versioning and enrichment of the content with ontologies to enable stakeholders easily retrieve the necessary content. Auer and Jungmann (Auer *et al.*, 2007) also argue that semantics can reduce the limitations that wikis present regarding the lack of context, which limits the construction of rich queries and leads to the poor representation of the results. In addition, they support this claim by implementing a semantic wiki, namely SoftWiki (Lohmann *et al.*, 2008) to manage the requirements elicitation needs of various teams inside the T-Systems Multimedia Solutions corporation. The promising results attained by this attempt indicate that semantic capabilities combined with the wiki technology can further boost the requirements elicitation process and make it even more effective for the company that needs it.

Finally, as Solis et al. (Solis *et al.*, 2009) propose, the process of requirements elicitation– and especially during the phase of the information system architecture definition– can be significantly enhanced through the use of visual means. To this end, they propose Shywiki, a platform that supports various visualizations, such as grouping by colour, to provide more clarity and facilitate the definition of information systems project requirements.

3.2.1.4 Collaborative End-User Programming

A common problem of information systems development encountered by end business users is that the traditional business applications are not always tailored to their individual needs. On the other hand changing these applications, and their respective source code, is often very difficult and implies specialized programming skills. End user programming enables non-professional business users to create or modify information systems artefacts so that they will perform computational tasks not directly supported by the business application at hand (Lieberman et al., 2006). End-user programming applications include tools to develop a variety of software modules, ranging from 3D models (SketchUp, 2011), process workflow scripts, visual language programming artefacts (LabVIEW, 2011, MindStorms, 2011), or spreadsheet models used for corporate budgeting or risk analysis tasks. The main added value that wikis offer to the end-user programming approach is the extended

support of the collaborative perspective, which can significantly reduce the fault levels inherent to typical software development involving non-professional users. To this end, a number of studies explore the capabilities of wikis in facilitating end-user programming.

More specifically, wikis are enhanced with SAP functionalities in (Anslow and Riehle, 2007, Anslow and Riehle, 2008). The SAP business application allows users to build information systems tailored to their individual needs, i.e. for "one-off computational tasks". In the aforementioned work, researchers propose Wiki Docs, a platform based on MediaWiki, to allow users to document, query and execute SAP business objects, thus creating a lightweight end-user programming environment. These extra facilities that Wiki Docs incorporates enable the effective processing of business data and provide a promising solution towards wiki-based end-user programming.

Xiao and Chi (Xiao *et al.*, 2007) also argue that the wiki-based information system development is a very efficient way of enabling large communities of end users to develop software that suits both their individual and group needs. The platform that they propose, namely Galaxy, enhances traditional wiki capabilities with extra programming functionalities, such as compiling, executing and debugging, to allow end users handle their Java source code through wiki pages and also to use the code of other programmers by referencing the corresponding wiki content. The resulting platform is a lightweight and highly collaborative on-line programming Java environment.

A different concept regarding end-user programming is proposed by Lotufo et al. (Lotufo *et al.*, 2009). In this work, wikis are coupled with the idea of "literate programming", a technique which combines conventional programming with text formatting languages, in order to maintain the developed source code and its supporting results and documentation together. To this end, the authors propose Adessowiki, a collaborative wiki-based programming environment which links the source code of an information systems product with its documentation and with the visualization of its results, in order to facilitate end-user awareness and to enhance synchronism during the information system development process. Finally, to depict the broad range that this type of wiki platform could have, several potential use cases are reported.

A number of concerns arise from the use of wikis to facilitate corporate end-user programming activities. A first issue refers to the fact that core corporate developers, working on client-side IDEs may not find it efficient to leave their typically used environment and connect to the wiki to extract potentially useful collaborative-oriented programming artefacts. A potential solution, suggested by the literature (Xiao *et al.*, 2007), is to facilitate the integration of the end-user programming wiki platform to the IDE environment of corporate workers, through the development of plug-ins that will connect the wiki content to IDE files and processes. Another issue refers to the interface of the wiki platform, which may not support the development of complex applications due to the restricted spectrum of available facilities and functionalities. Thus, it is suggested to enhance the provided end-user online programming experiences through richer user interfaces which will include features such as automatic indentation, keyword highlighting, code formatting, as well as graphical tools to create queries and execute the developed source code.

The aforementioned studies reveal that wikis have the potential of facilitating the corporate information systems development process, of fulfilling the communication requirements among development teams and of providing the corporations that use them with strategic advantage against their competitors. To further enhance the benefit that they can offer, wikis used in the process of information systems development can be accompanied with tools to handle source code, which will enable developers to interact more efficiently. Enhanced content classification and retrieval capabilities are also expected to be highly useful and to this end, semantic solutions can be implemented together with the provision of detailed guidelines regarding the way that each contribution should be categorized by the users. Finally, the ability of customization can also help adapt the wiki to the specific information systems development requirements of the corporation. Table 5 summarizes the main advantages, concerns and solutions of the wiki usage in corporate information systems development activities.

Table 5. Wikis in corporate information systems development and maintenance: Advantages, concerns and proposed solutions

Sub-process	Target activity	Advantages	Concerns	Proposed solutions
Information systems documentation	▪ Facilitate the documentation during the information system	▪ Speeding up of the information systems documentation process ▪ Facilitation of the	▪ Need for support of synchronous communication (instant messaging, web conferencing)	▪ Use of highly customizable platforms

	development process	communication among developers	▪ Need to support complex document types ▪ Need for easy customization ▪ Security ▪ Potential inaccurate content ▪ Potential conflicts due to different writing styles	
Software reuse	▪ Use of existing source code samples for the needs of future corporate information systems development projects	▪ Increased content reuse ▪ Increased user motivation towards reuse	▪ Need to ensure quality of the content to be reused	▪ Quality management through the use of tags to filter non-qualitative information
			▪ Need for enhanced structural support to facilitate content retrieval	▪ Content retrieval enhancement through • Use of predefined taxonomies • Semantic features • Naming conventions to facilitate content categorization
Requirements engineering	▪ Elicit the conditions that an information systems product needs to meet	▪ Facilitate distributed, interdisciplinary stakeholder collaboration ▪ Achieve effective stakeholder synchronization ▪ Acceleration of the information systems product completion	▪ Need for enhanced versioning support ▪ Need for comprehensive stakeholder training	▪ Version tagging and cross-page versioning ▪ Provide stakeholders with appropriate technical guidance
End-user programming	▪ Enable non-programmer users to adjust the information system to perform not directly supported tasks	▪ Lightweight end-user programming environment ▪ Facilitates customization of the information system by the end-user	▪ Need for IDE integration ▪ Restricted spectrum of available functionalities	▪ Plug-ins to connect the wiki content to IDE files and processes ▪ Rich user interface inclusion and provision of more complex facilities

3.2.2 Management Activities

Project management is the organizational function related to the processes of planning, organizing, directing and controlling the development of a project, of tracking and recording the work that needs to be performed and generally of identifying the risks and making decisions that will ensure the quality and the success of the project (Stubblefield and Carson, 2007, Nielsen and Dolog, 2008). In this context, a number of studies explore the use of the wiki technology in facilitating the project management processes.

3.2.2.1 Decision Making

A first important aspect of project management refers to decision making. That is, managers often need to make strategic decisions, which will affect the evolution of the project, under conditions of uncertainty. To make the decisions taken more well-defined, there is a need to identify and assess the risks that might compromise the final success of the project. In this context, collaborative web-based tools have started to be considered, in order to facilitate decision making and to overcome potential fault decisions that might occur as a result of a misjudgement of the inherent risks (Watkins and Rodriguez, 2008, Heineke *et al.*). As Suggs and Lewis (Suggs and Lewis, 2007) suggest, the wiki technology can be used to enhance strategic decision making by efficiently supporting enterprise modelling, i.e. the process in which managers use simulation models to virtually examine their ideas and prevent potential decision faults from negatively affecting the corporation. Spreadsheets, a tool typically used for enterprise modelling may be flexible, yet they do not provide the version control, scalability and collaboration capabilities often needed. The wiki-based collaborative platform, namely Vanguard System, proposed by the aforementioned study provides managers with a number of computing capabilities to support decision making, such as Monte Carlo simulation, forecasting, optimization and decision tree analysis. The platform also enables the use of grid computing to accelerate the computationally intensive simulation processes and foster scalability. Graphical capabilities to provide visual feedback regarding the business model assumptions and building blocks are also supported. A final important capability refers to the support of different types of enterprise modelling skills, i.e. users with limited modelling creation knowledge can use the stored pre-built models, while more expert users can view the internal functionality of each model and contribute their knowledge to the existing content.

Despite the advantages it can gain the organization, a main concern, of the collaborative, wiki-facilitated process of decision making, refers to the quality of the information that the wiki platform will eventually provide the manager with. As the literature reveals (Raymond and Bergeron, 2008) the quality of this information output has a direct impact to the level of support that the manager receives regarding their decision-making tasks and in turn may affect the overall project success. It is therefore important to seek the validation of the outputted information quality, either through manual means, such as a dedicated group of wiki information curators, or through more automated means of quality assurance (Lykourentzou *et al.*, 2010).

3.2.2.2 Project Planning and Organizing

Planning is another vital part of project management, related to the scheduling and planning of the various activities that will take place within the project environment. To achieve successful planning, managers need to possess a complete and accurate overview of all the activities taking place inside the project. However as Li et al. (Li *et al.*, 2009) point out, retrieving the information necessary to perform the above supervision task may be difficult to accomplish manually, due to the large amount of content typically hosted by corporate wikis. To this end, they propose using external programming to automatically distil the essential information which needs to be processed. The method proposed by this study removes the unnecessary information – such as HTML tags – from the target wiki pages and then it accumulates the remaining content in order to enable its more effective processing by corporate stakeholders.

Furthermore, to facilitate project planning, various studies propose combining the collaborative nature of the wikis with real-time recording and tracking of the ongoing activities, as well as with visualization techniques.

Real-time tracking, i.e. measuring the progress of a project in an automated, concurrent manner, is a critical process, which if effectively accomplished can increase managerial awareness regarding the status and timetable of each undertaken task and can thus help managers define the actions necessary to achieve overall project success. However typically managers need to supervise the ongoing activities through manual means of tracking and recording, a task which may prove to be especially difficult in case of large projects or of smaller projects running simultaneously.

The experience of successfully implementing a wiki-based project management system, namely Trac, which provides real-time process recording within a large-scale project is described by Stubblefield et al. (Stubblefield and Carson, 2007). Trac was implemented to support the managerial team of the Integrated Stockpile Evaluation project (ISE), a project which deals with the maintenance of the weapon stockpile of the United States and more specifically with overseeing the planning, funding, tracking and reporting on several related sub-projects. Based on the collaboration and the contributions of the involved teams, the platform provides real-time tracking

features which include recording the project meetings, informing the managerial team regarding the status of the project partners, providing financial tracking and delivering team resource allocation capabilities. Stakeholders can oversee and interact with the recorded processes, for instance by commenting on them.

Real-time process recording can also prove beneficial to another type of corporate management that slowly starts to emerge (Augustine, 2005). That is, nowadays increasingly more corporations base the development of their products – especially information systems artefacts – on agile methodologies, such as extreme programming (Layman *et al.*, 2006). These techniques generally do not adhere to a strict development model but they rather target at being more responsive to the changes that might emerge throughout the life cycle of the project. As such, they typically involve a flat organizational structure where managers, customers, and developers are all equal partners in a collaborative team, which self-organizes to solve the problem at-hand. The management of this type of projects is typically performed by a person, responsible for recording the progress of all involved teams, through face-to-face meetings, a process however which may introduce delays and result in the less effective project planning.

Angioni et al. (Angioni *et al.*, 2006) suggest that wikis can help overcome this issue and propose XPSwiki, a tracking system for agile project management. XPSwiki collects all the data related to the progress of a project in electronic format, thus lowering the need to exchange, organize and store project related documents via various other means. To perform the above, it supports three types of features. These include allowing users to directly enter relevant project information, automatically tracking certain project activities, such as time spent on each time of stored information and integrating the wiki environment to the IDE of the developers, to enable them directly access the recorded process data. Through the above features it allows managers to assess the overall project progress in a real-time manner and in this way to decrease the delays introduced through the manual tracking of project activities. Despite the advantages of the tracking technology, researchers also point out a privacy concern, related to the misuse of the recording of the behaviour of developers. To this end, they suggest that a mutual agreement of all the entities involved in a project should be sought before the launching of such a management system.

Apart from real-time tracking of the ongoing activities, another feature that can be particularly helpful in providing managers with the necessary level of awareness refers to the combination of wikis with visualization techniques. These techniques are explored by Ding et al. (Ding *et al.*, 2007), as part of a wiki-based solution deployed by the Research institute of the IBM organization to facilitate its annual project planning processes, making it more transparent and by increasing the awareness of the involved stakeholders regarding the ongoing projects. A traditional wiki platform, used prior to the visualization solution, had not returned the desired outcomes, since users reported reduced content accessibility, as well as maintenance difficulties, which subsequently resulted in out-of-date information that did not reflect the current projects status. To address the above, researchers created a visualization layer, namely CherryTree, which provides an overview of all the ongoing projects inside the corporate wiki. Some of its features include graphical representations of all the entities engaged in each project, such as research labs and contributing persons, as well as a visualization of the interconnections among research teams or projects. Visualizations are also enhanced with different colourings to depict the time that has elapsed since the last update of each type of information. This new form of planning resulted in increased community awareness, since individuals could easily see who contributed to which project and to what extent. Improved accessibility was also observed, since it was easier to navigate through the visualized wiki. Finally, better maintainability was achieved, since users tried more to keep their projects up-to-date, bearing in mind that the status of their work was easily observable by other users inside the corporation.

This latter indication, revealed through CherryTree, i.e. that making individual actions visible, triggers user participation since individuals wish to return to the norm, is also supported by other studies in the literature both in the general social system domain (Erickson, 2008) as well as in studies specifically related to wikis. As Neumann et al. (Neumann and Erol, 2009) point out, although the organizing of corporate processes through wiki-based means can make the management of a project workflow more collaborative and dynamic, yet this effort also requires making the involved group of users more aware regarding the activities taking place inside the wiki. Thus, they propose a wiki system, namely Xowiki, which is created to support workflow management by providing a visual illustration of the interdependencies between the states of the workflow and the actions that cause their changes. Each state

inside a business process - for instance the current state of a proposal - is represented by a dedicated wiki page that can be edited to reflect an action, for instance the acceptance or rejection of the proposal. In this way all the actions and intermediate states that occur during the project life cycle are directly illustrated, through an activity graph, to the users, a fact that enhances transparency and responsiveness. To further enhance group awareness, Xowiki provides a visualization of the actors involved in the project workflow, based on an on-the-fly analysis of the involved user activities.

3.2.2.3 Managerial Experience Sharing

Apart from facilitating decision making and project planning, wikis can also prove to be a valuable tool for capturing and sharing managerial experience. With the percentage of projects which manage to preserve their expected cost budget or to deliver the desired functionality not being sufficient (Petter and Vaishnavi, 2008) , it is important to find effective ways of avoiding past mistakes and providing overall successful project outcomes. In this context, the recording and the dissemination of the implicit experiential knowledge gathered by managers, for instance in the form of best practices, is another important research concern (Nielsen and Dolog, 2008).

As Petter et al. (Petter and Vaishnavi, 2008) point out, traditional knowledge management systems often fail to capture managerial expertise, because they mostly focus on recording formal attributes of past projects, such as procedures, technical specifications and templates, rather than on capturing the methods, procedures and facts that constitute the actual experiential knowledge of project managers. This failure often leads managers to seek other means of mutual knowledge sharing, such as interpersonal communications, which however are not always plausible, due to spatiotemporal restrictions. To this end, the aforementioned study proposes a wiki-based managerial knowledge sharing system, namely Experience Exchange Library, which aims at effectively addressing the above issues through community-based efforts and design principles. A number of interesting features are included in the above system, such as the problem statement functionality, which allows managers to describe the problem that they solicit knowledge about and acquire answers in the form of lessons learnt and best practices. In addition, a taxonomy is implemented to facilitate search inside the wiki, while a glossary of terms is also provided, to familiarize new users with the jargon typically used inside already formulated project

communities. Moreover the platform incorporates narrative means of experience sharing, through written, audio of video form, to facilitate managers easily record their skills and boost organizational learning. Finally, recognizing the need of providing managers with the proper incentives to share their expertise, the above study proposes implementing lists of top contributors, measured through the number of posts made or based on the rating that one's contributions receive by other users.

Concluding, as the aforementioned studies reveal, the wiki technology can be used in a quite successful manner to facilitate the work of project managers in a variety of processes which include the decision making, the planning of a project and the reuse of the managerial experience gained. The main benefits that this collaborative technology gains managers are the automation of the recording work that needs to be performed and the real-time reflection of the project status, which in turn lead to the increased stakeholder awareness and to the better coordination of the project teams. Despite their advantages, certain concerns do exist and mainly refer to privacy issues, related to the automated tracking of the employee activities for project management purposes, as well as to the need of providing managers with incentives of participation and sharing their expertise. Table 6 summarizes the merits, concerns raised by the usage of wiki technologies in management activities and highlights potential solutions enhance their functionality within the corporation.

Table 6. Wikis facilitating corporate management activities: Advantages, concerns and proposed solutions

Sub-process	Target activity	Advantages	Concerns	Proposed solutions
Decision making	▪ Make strategic decisions, regarding the project. ▪ Identify, evaluate and address the risks related to the success of the project.	▪ Strategic decision making enhancement through: • Provision of computing capabilities to support decision making (Monte Carlo simulation, forecasting, optimization and decision tree analysis)	▪ A low-quality wiki information output may result in limited support of the decision-making tasks and affect the overall project success	▪ Validate information output through manual or automated means
Project planning and organizing	▪ Schedule, plan and organize the project activities	▪ Increase of the managerial awareness regarding the ongoing project tasks through: • Real-time tracking features • Visualization techniques	▪ Privacy concerns, related to the potential misuse of the recorded user activities and project processes	• Mutual agreement accomplishment between all the entities involved in the project prior to system launch

Managerial experience sharing	▪ Capture and share past-project managerial experience	▪ Effectively share managerial expertise through: • Narrative means of experience sharing • Glossary of terms	▪ Need to provide managers with incentives to share their knowledge	▪ Motivation provision through "top participant" lists

3.2.3 Interaction with third parties

Nowadays, the ever-changing needs of the customers, suppliers and partners and the aim to fulfil these needs in a prompt, reliable and competitive manner necessitate the adoption of more interactive approaches and the discovery of new ways to actively engage these third parties into corporate processes. The open nature and the collaborative capabilities that wiki systems present in addressing this need for interactivity, have led an increasing number of corporations to examine their adoption (Challborn and Reimann, 2004, Liang and Tanniru, 2007, Hearn *et al.*, 2009, Socialtext, 2010). In the literature three main categories of wiki usage for the facilitation of third parties relations are identified: help desk support, marketing and advertising and participatory publications.

3.2.3.1 Help Desk Wikis

A typical service provided to customers, suppliers and partners by corporations is the help desk provision. Help desks usually consist of expert employees that provide customers with support and information regarding corporate products and services, typically through toll-free telephone numbers, e-mail exchanges and static corporate websites. As far as help desk software is concerned, this appears in varying formats depending on the corporate needs that it addresses. Such software formats may include web based, local software with some degree of web integration, or completely localized software which needs to be installed on each corporate server or workstation (HelpDesks.com, 2011). Compared to web-based help desk software, which is the closest format to help desk wikis, the latter present the shortcoming of not providing the level of technical support that fully commercial help desk software platforms offer. Nevertheless, help desk wikis present the advantage of collaboration enabling – among technicians and customers – and the benefit of being a typically lower cost solution, as far as purchase, maintenance and upgrading are concerned. Inspired by the aforementioned, as well as by the advantages that wikis present in keeping the required information up-to-date while being efficient and easy-to-use,

corporations gradually start to examine their use as a means of implementing a help desk facility.

Wagner and Majchrzak (Wagner and Majchrzak, 2007) describe the experience of Novell corporation in using MediaWiki to build a community of experts to answer technical questions and provide customers with information and support regarding software products. Prior to the launch of the wiki, the community exchanged questions and answers through a discussion forum. However this approach resulted in long forum pages that made navigation and search difficult, while newer posts tended to obscure older ones due to the chronological ordering of the forum discussions. The collaboration outcomes of an eleven-month wiki implementation period were successful, with a wide participation of 1.900 registered wiki members, 1.300 wiki pages created and 330.000 views. To enhance participation, Novell provided users with different access rights and responsibilities depending on their involvement. However despite the high levels of participation, a concern was raised about the restriction of the wiki role to responding customer FAQs only, instead of involving the participants in content co-creation. Finally, concerns were also raised by a number of marketing managers regarding the fact that customers might add to the wiki content referring to the corporation in an unfavourable light.

An additional implementation of a wiki as a help desk service is reported by Clein and Smith (Klein *et al.*, 2007). In this case study, the wiki was used by the IT department of Valparaiso University to provide the members of the public with information on various technological issues, such as hardware systems and software processes. Prior to migrating to the wiki, the IT department used a password-protected knowledge base modifiable only by a few individuals. This made the update process cumbersome and often resulted in outdated information. The wiki system incorporated a number of features, especially useful for corporate needs, such as LDAP authentication and moderation features to allow information visibility only after management approval. In accordance to other studies in the literature, the wiki was pre-populated with existing departmental documentation, a process which revealed inadequacies in the method previously used, since more than 50% of the documents required modification and updates. The outcomes of a one-year period of wiki implementation revealed that it attracted a significant amount of participation (Klein and Smith, 2008), while it helped enhance the processes that took place in an everyday basis in terms of quality and acceleration. Despite its success, the study also

reports that in the aforementioned period of time the wiki had not been fully incorporated into the everyday routine of all the employees, since part of the staff preferred to directly consult other help desk specialists, instead of consulting the wiki, while there was also a constant need to remind the employees to keep the stored information up-to-date.

3.2.3.2 Marketing and Advertising

Apart from providing customers, suppliers and partners with support regarding products and services, companies nowadays can also benefit from the wiki philosophy to facilitate their advertising and marketing strategies.

Walt Disney is one of the first media companies to release a wiki web site, namely "ParentPedia", in an attempt to actively engage expert and non-expert visitors into exchanging opinions and advice regarding parenting issues (Garrahan, 2007). The wiki, which also contains an aggregation of links to various parenting sites and an RSS functionality, provides customers with better feedback, while it also solved the email overloading problem that the company faced prior to the use of Web 2.0 tools. However besides the benefits that Disney reported, some problems were also mentioned, regarding authentication issues and the hesitance of the staff to take up and support the new collaborative technology (Creese, 2007).

Another interesting effort of wiki usage was the one performed by the ABC television network. In this case, wikis were used to build online communities around popular television shows ("Lost", "Boston Legal"). Fans are encouraged to co-edit the scenario of the series and share their ideas, while the whole wiki is used to advertise the firm that hosts it (Bambi, 2006).

Besides using a wiki to market products to their customers, corporations often host a wiki to facilitate customer to customer communication and to facilitate products reviews and services. Examples of this practice include Shopwiki.com and ProductWiki.com, which provide comparisons among online products, based on the inputs made by consumers or experts (Deans, 2009). On the field of services provision, Wikitravel.com offers accumulated recommendations and advice about travel and tourism offered by customers worldwide (Levine, 2006 , Wikitravel, 2010).

3.2.3.3 Participatory Publications

A process associated with customer, suppliers and partners' relations, in which wikis are slowly starting to emerge, is that of participatory publications. This change is not random but it is dictated by the rapid technological, social and economic changes brought on by the advent of the web and especially web 2.0 technologies, through the use of which users worldwide can cover the news and access much broader audiences than through the traditional news industry (Kolodzy, 2006). This phenomenon challenges the role of today's news organizations that now need to develop novel ways to keep the interest of their current or prospective readers. In view of these changes and inspired from the outstanding success of Wikipedia, a number of online and print publications (BBC, 2010) have experimented with the use of wikis, in an attempt to involve the public in the article writing process. As the literature reveals, this procedure demonstrates both successful and ineffective examples.

A main concern regarding the use of wikis in participatory publications refers to the potential danger of vandalism. For example, (Wagner and Majchrzak, 2007) and (Bradshaw, 2007) present the cases of a large mainstream media organization, which released a wiki webpage to enable its readers co-create article pieces. In the specific case, the wiki was seeded with an editorial about Iraq, and invited all interested users to contribute. The attempt was unsuccessful, since extended web-vandalism occurred within the first 24 hours, resulting in the adulteration of the wiki. To avoid this phenomenon, literature proposes providing the customer community with mechanisms that will prevent destructive users from entering the site (Dorroh, 2005, Wagner and Majchrzak, 2007). Such mechanisms could include ascending privileges to trustworthy customers, as well as automatic mechanisms that will block malicious alterations. Additionally, the scope of the corporate wiki should be clearly defined and disseminated to the customers, possibly through the establishment and description of explicit contribution guidelines, in other words, a "wiki etiquette".

In other cases, wikis have been successfully used to involve external entities into participatory journalism. In 2006 the Wired magazine experimented with a wiki platform called SocialText, towards achieving the collaborative editing of an article about wikis (Bradshaw, 2007). Firstly, a 1000-word draft was submitted to the editorial office, then the wiki version of the article was pre-populated with the same draft and finally registered members were invited to enhance the uploaded draft. Eventually, the wiki version of the article was found to be more precise and enriched

compared to the non-collaboratively written version. However it was observed that the wiki article lacked the narrative style of the magazine and looked more like a "primer" and less like a fully cohesive story. Another successful example, also mentioned in the same study, is the experiment conducted in 2005 by the Esquire magazine. As in the previous case, the readers were encouraged to contribute to and edit an article about Wikipedia. In this case, the article received 224 edits in 24 hours and experiment was so successful that the author of the study reports considering the possibility contributing more of his articles to be written this collaborative wiki-based writing style.

A different attempt to engage third parties in participatory publications is mentioned in (Mason and Thomas, 2008). This study describes the effort performed by Penguin Books and De Montfort University to involve the public in a novel co-creation. To encourage participation, the wiki was initially seeded with the first line from a volume of the Penguin Classic series. An initial period of web-vandalism was appeased by policing the edits and by continuously removing irrelevant content. As soon as a period of stability was reached successful results were reported, with a large number of approximately 75000 editors and visitors of the wiki novel. Although successful, the original purpose of the wiki adoption was not fully accomplished since a printed novel could not be derived from the multiple interwoven wiki links that were produced. A final issue that the study points out is the detractive spirit in which the novel was viewed by both other authors and publishers.

Summarizing, the wiki technology, as a means of managing and enhancing the relationship of the enterprise with its customers, suppliers and partners is increasingly drawing corporate attention and it has been used in a variety of different contexts, revealing a number of both advantages and challenges that need to be considered prior to its adoption. When used as help desks, wikis have generally proved to be functional mainly due to their efficiency in collecting community knowledge and distributing it among community members. Minor problems in this approach have to do with the third parties hesitation in consulting and contributing to the help desk wiki, an issue which may be amended as this new means of communication is gradually being incorporated into people's everyday routines. Wikis are also reported to be effective in advertising corporate products and services, by facilitating customer communication and collaboration and thus helping the enterprise adopt more customer-centric marketing approaches. However when third parties are engaged with

topics of a less entertaining and of a more controversial nature, wikis are not always effective, as revealed by the case studies of wiki usage in news organizations. Although there are a number of successful stories about article co-creation, the issue of vandalism still remains a great challenge when external entities are involved. Table 7 illustrates the advantages, concerns and proposed solutions regarding wiki usage in the process of corporate interaction with third parties.

Table 7. Wikis facilitating interaction with third parties: Advantages, concerns and proposed solutions

Sub-process	Help Desk Wikis	Marketing and advertising	Participatory publications
Target activity	▪ Provide external entities with support regarding corporate products and services	▪ Advertise corporate products and services though active third party involvement	▪ Enable the public participate in the creation of news and publications
Advantages	▪ Information kept up-to-date ▪ Easy to use solution	▪ Direct third party engagement ▪ Reduction of e-mail overloading problems	▪ Maintain readership levels by actively involving the public
Concerns	▪ Restriction to simple FAQ repository instead of full external party involvement ▪ Managerial concern regarding potential negative third party reviews	▪ Concern regarding authentication issues	▪ Potential vandalism issues ▪ Wiki article not directly publishable in print format
	▪ Staff hesitance to take up the new technology		
Proposed solutions	Moderation features to allow content visibility after management approval		▪ Provide external entities' community with mechanisms to prevent vandalism: • Ascending privileges to trustworthy third party entities • Automatic/non-automatic mechanisms to block malicious alterations • Introduction of "wiki etiquette"

3.2.4 Organizational Response in Crisis Situations

Another process in which organizational collaboration is highly significant is the planning and response in emergency circumstances. Such emergencies include for instance the Kobe earthquake in 1995, the Indian Ocean Tsunami in 2004 and the Katrina hurricane in 2005. As the literature reveals, this type of situations could be more effectively addressed through the use of emergency response information systems (Van de Walle *et al.*, 2009), which play a key role in achieving timely organizational preparedness and in disseminating awareness, especially when traditional communication systems are down (Jang *et al.*, 2009).

Wikis are among those technologies that are increasingly being selected to serve as community-based emergency response information systems. As an indicative

example, the study of Plotnick et al. (Plotnick *et al.*, 2008) explore the potentials of this technology in supporting the communication among partially distributed teams (PDTs), that is virtual teams used by organizations to achieve collaboration and emergency preparedness. A pilot study was thus conducted, involving 117 users from different locations across the world and aiming at effectively addressing the aftermath of an emergency situation in a specified Latin American country, as well as meeting the respective needs of the affected population. A four week qualitative log analysis indicated that the wiki was selected as the major communication medium among several collaboration technologies available. In addition it alleviated a number of barriers that PDTs typically have to overcome, such as the time lag between the geographically dispersed groups and the assignment of the necessary leadership roles across the system users. Nevertheless, a concern raised referred to a difficulty that non-American users might face in using the wiki platform, an issue that the researchers attribute to the cultural differences between the geographically distributed teams.

Apart from organizations that collaborate towards addressing worldwide emergencies, another type of large-scale organizations also involved in the emergency domain, is colleges, which often develop their own emergency situation platforms to promptly address on and off campus crisis situations. In this context, Raman (Raman, 2006) performs an indicative case study regarding the implementation results of a wiki platform at the emergency operation centre of Claremont Colleges. The wiki was applied through two drill emergencies and the results yielded through its use were promising. Specifically, an interview with the members of the emergency operations centre of the college revealed that the wiki effectively supported cross-unit collaboration, enhanced the communication and knowledge distribution among the involved units, including the federal and local agencies. Nonetheless, a major challenge revealed was the unfamiliarity that users had with the editing processes of the wiki tool, an issue which seems to have caused a medium usability score of roughly 70 percent.

The issue of user unfamiliarity with the emergency response platform is critical, especially when the time to provide training is not sufficient. To address it, White et al. (White *et al.*, 2008) suggest implementing a platform with which users are already familiar with. As an example, they propose emergenciWiki, a system based on the popular – due to Wikipedia - MediaWiki platform, with a simple interface suitable

even for novice users. The increased participation levels that the system had, during a two-month monitoring period, indicate that it could serve as a valuable and lightweight community coordination tool. Apart from user-friendliness, the study also points out that content reliability is another critical issue in the process of organizational response to crisis situations. To ensure the production of qualitative content, the authors suggest restricting the contribution capability, only to trustworthy users. To this end, emergenciWiki is open to contributions only by EMTC, a community which comprises professionals within the emergency management arena.

Another means of addressing the issue of potentially flawed content, in wiki-based emergency management systems, is proposed by Eryilmaz et al. (Eryilmaz *et al.*, 2009). This study proposes SECURE, a system that evaluates the trustworthiness of a wiki author that describes an emergency incident, by calculating the accuracy of this information dissemination, based on algorithms that operate according to the author' s citations. The system also includes visualization tools to further increase awareness and facilitate emergency planning.

Finally, besides it use as an information management system, the wiki technology can also be used as an integrated part of a more general disaster management system as Hansberger et al. (Hansberger *et al.*, 2010) recently presented. Their study introduces the emergency response environment that the army research laboratory in collaboration with a number of universities, proposes in order to achieve community and activity awareness.

Summarizing, as illustrated in Table 8, the wiki technology can enhance the information parcelling among and across organizations involved in emergency situation responding, either as a standalone information management tool, or as an integrated part of a wider crisis management system. However what is also revealed by the research literature is that existing implementations do not completely take advantage of the potential of wikis for dynamic real-time collaboration (White *et al.*, 2008), since wikis are currently being used only as static pages of knowledge distribution. Taking into account that a number of studies (Liu *et al.*, 2008, White *et al.*, 2009, Underwood) indicate that emergency response management tends to occur also through social network sites – for instance Facebook, which alone supports numerous emergency related organizations –, future research on the topic could include merging the structured content of wiki technologies with the organizational

linking capabilities of social networking, to address emergency situations in a more complete manner.

Table 8. Wikis facilitating organizational response to crisis situations: Advantages, concerns and proposed solutions

Target activity	Advantages	Concerns	Proposed solutions
▪ Organizational planning and response to crisis situations	▪ Alleviates time lag between the geographically dispersed, emergency response groups ▪ Effective support of cross-unit collaboration	▪ Low participation due to user unfamiliarity with the platform ▪ Potential flawed content	▪ Increase participation through: • Using a simple platform that users are familiar with ▪ Enhance content reliability through: • Restrict the contribution capabilities only to trustworthy users • Calculate author trustworthiness

4. Functional and Technical Features for Wiki Platform Comparison

Based on the research works discussed above, this section provides an overview of the wiki features that are mostly used in each one of the presented organizational processes, as well as the respective features supported by each one of the platforms examined in the literature.

In particular, Table 10 presents the functional wiki features, which are most frequently used by the studies in each one of the organizational processes discussed above. This table can be used complementary to external online wiki review resources (CosmoCode, 2011, Wikipedia, 2011c, Wikipedia, 2011b), which illustrate the functional and technical features supported by both the wiki platforms examined in the related literature, as well as by other available wiki platforms, to help readers decide on the platform that is more appropriate for each specific organizational task.

Table 9. Main functional wiki features used by each organizational process

	Basic			Syntax – Formatting			Structure					Search - Navigation			Security				Visualization				Personalization		Complex document support					Computing capabilities						Special pages			other						
Organizational Process	**1a**	**1b**	**1c**	**2a**	**2b**	**2c**	**3a**	**3b**	**3c**	**3d**	**3e**	**4a**	**4b**	**4c**	**5a**	**5b**	**5c**	**5d**	**6a**	**6b**	**6c**	**6d**	**7a**	**7b**	**8a**	**8b**	**8c**	**8d**	**8e**	**9a**	**9b**	**9c**	**9d**	**9e**	**9f**	**10a**	**10b**	**10c**	**11a**	**11b**	**11c**	**11d**	**11f**	**11g**	**11h**
Knowledge codification	X	X		X						X		X		X	X	X			X	X				X			X	X				X			X	X			X			X			
Communities of practice	X		X		X	X		X	X				X	X	X								X																						
Interaction with third parties	X	X		X												X																						X						
Software development	X	X	X		X		X	X	X		X	X		X	X		X	X		X		X	X		X	X					X	X		X				X	X	X		X	X	X
Management activities	X						X												X		X	X							X	X			X	X	X		X		X					X
Organizational response in crisis situations	X	X		X																																								

5. Discussion, trends and future research directions

This section provides a discussion over the topics and the works examined, by focusing on a variety of issues of interest – such as the enablers and constraints of the wiki usage in corporate environments or the use of wikis in corporations of different size – as well as by identifying trends and future research directions on the field.

5.1 Enablers and constraints of the wiki usage in corporate settings

Based on the notions and works discussed in the previous, as well as on a specific set of recent literature studies (Grudin and Poole, 2010, Hester, 2010, Holtzblatt *et al.*, 2010, Wagner and Schroeder, 2010, Yates *et al.*, 2010), one may identify a number of enablers and constraints, related to the two main aspects of the wiki usage in enterprise settings, namely the cultural and the technological.

5.1.1 The cultural corporate wiki aspect

Overall, as far as the cultural aspect of wikis is concerned, it seems that establishing an open, knowledge-sharing culture inside the organization is a key factor towards a successful wiki implementation. Indeed, the majority of the successful cases examined, did foster a bottom-up sharing approach towards knowledge creation. Flat-based or innovation-welcoming corporations also seem to better support the wiki establishment, since knowledge in these environments is considered to be less of a personal and more of an overall corporate asset. On the opposite direction, organizations that address the issue of knowledge creation in a strictly hierarchical, top-down approach seem to be less likely to effectively sustain a corporate wiki, mainly due to the sense of giving away ownership and limiting the chances that one stands towards inner competition that employees have; a fact that subsequently causes participation reluctance and the potential abandonment of the wiki.

Management support plays a vital role in establishing the appropriate wiki culture inside the organization, as well as in maintaining the results of the wiki usage. That is, the most successful among the stories examined were the ones in which the management actively encouraged participation and provided the employees with a number of knowledge sharing incentives. A number of steps that seem to be efficient towards this direction include the incorporation of the wiki into the daily routine and the everyday communications of the employees, as well as the provision of adequate time and training for the familiarization of the latter with the functionality of the

platform. Indeed, the unfamiliarity of the employees with the editing processes was related, according to a number of the analyzed studies, to very low usability ratios and to a reluctance of the employees to use the platform. The recognition of the wiki contributions as part of one's work description is also critical, especially taking into account the fact that wiki editing is inevitably a time-consuming process. The provision of knowledge sharing incentives seems to also be beneficial, and it can be provided in the format of either tangible rewards – for instance as part of a more general corporate strategy of rewarding the acquisition and sharing of new skills – or intangible ones. One of the strongest intangible rewards, mentioned by both the examined studies and by the wider knowledge-sharing literature (Osterloh and Frey, 2000, Cabrera and Cabrera, 2002, Kankanhalli *et al.*, 2005, Wasko and Faraj), refers to authorship recognition – for instance in the form of "top participants" – an incentive which has been found to increase the perceived self-efficacy of the employees, as well as the benefit that they see in sharing their knowledge. Building a safe-to-contribute environment, where the contribution of "work-in-progress" is not negatively judged but it is perceived as part of the development process and it is positively evaluated, was also observed to be a motivating factor. Finally, a number of studies mention that another means of motivating employees to participate, is the promotion of team spirit and the cultivation of a group identity within the corporate wiki community, through for instance encouraging them to create their personal profile pages or to build closely-linked, self-managed units inside the corporate wiki.

5.1.2 The technological corporate wiki aspect

On the technological level, simplicity, user-friendliness and structural support and security seem to be four of the most frequently enablers mentioned in almost each one of the examined organizational process categories.

As revealed in the analyzed studies, selecting the simplest wiki solution that can meet the organizational requirements, can help reduce the complexity of learning to use the tool and, in this way, it seems to contribute towards increasing participation and promoting the wiki usage in the enterprise (Richter and Koch). A simple core platform can then be extended with the exact additional functionalities that the organization needs. In fact, the examined literature shows a tendency towards this pattern, with a number of case studies preferring to select a simple, usually open source, platform and to customize it to fit the needs of their specific enterprise setting,

rather than using a ready-to-use solution. A typical customization process, observed in a number of studies, refers to extending a core wiki platform to support more complex file formats, compared to simple text, such as tables, spreadsheets, executable code, as well as enterprise simulation models. Finally, instead of customizing a platform and owing the necessary hosting and maintenance equipment, a number of studies report using already customized wiki solutions, which are offered as a hosted service by dedicated companies.

User-friendliness is another important technological enabler of the success of a corporate wiki, according to interviews performed with wiki participants by a number of the different studies examined. For instance, the provision of visualizations seems to significantly support management activities, while the use of comment visualization can increase workspace awareness among the members of a collaborating corporate team.

Structure seems to also play an important role to the success or failure of a corporate wiki implementation. That is, poor structural support often seems to result to laborious information insertion and retrieval, navigation difficulties and information duplication. Since wikis innately provide only loose structural rules, it is important to find a balance between directly using this kind of support and enforcing a very strict information organization schema, which limits creativity and collaboration potential. A popular solution, used by a variety of studies, refers to either using a simple solution – in the form of a predefined, editable topic taxonomy – or a more refined one, in the form of a semantic wiki. In addition, a number of the use cases examined make use of an alternative solution: the manual maintenance of the wiki content by a person or a core group of persons, also referred to as *"wiki gardeners"*, who are responsible for the correct classification of the information inserted into the wiki platform.

Finally, security is another important enabler of the success of a corporate wiki. Security pertains to assuring that the stored corporate content will not be accessible to unauthorized parties, as well as to guaranteeing that it will not be misused accidentally or on purpose. Large-scale corporations seem to be the ones mostly concerned with this issue and, to this end, tend to adopt a number of countermeasures, as it will be discussed in the respective following sub-section.

5.2 Wiki usage in organizations of different size

A number of interesting observations can be made regarding the wiki usage patterns in organizations of different size. The two main size categories most often encountered in the literature include small and medium enterprises and large-scale organizations.

5.2.1 Wiki usage in small and medium enterprises

As far as the wiki usage in small and medium enterprises is concerned, an interesting feature that can be observed refers to the effect of the personal element, which is present in these environments. Specifically, the fact that the employees may directly interact with one another on a regular basis can often prove beneficial for the usage and sustainability of the wiki, since people are less reluctant to share their work when they do not share it with complete strangers. In addition, as far as technology is concerned, a significant number of SMEs seem to prefer the solution of open-source solutions, since these provide a cost-free yet effective means of implementing a corporate wiki.

5.2.2 Wiki usage in large-scale organizations

On the contrary, the needs of larger organizations seem to be better supported by commercial or in-house made solutions, since these provide more security options, as well as more technical support compared to the ones offered by open source platforms. In case an open source solution is used in these environments, this is also highly customized – as most studies mention – prior to its launch on the corporate network.

An additional issue, that managers and employees in large organizations were especially concerned about, pertains to security regarding content quality. Although vandalism is not a widespread phenomenon in corporate wiki environments, yet the potential misuse of the content stored inside the wiki seems to be a main concern. Depending on the type of information that is included in the wiki, as well as on the nature of the organization, the solutions used, by the examined studies, to address this issue include establishing membership criteria, restricting editing to a specific group of corporate users, or assigning specific groups of users with the task of maintaining the content quality.

Another concern regarding the use and sustainability of wikis in large-scale corporate settings pertains to the establishment of trust among the wiki participants.

Trust may be harder to achieve among employees of a large firm, compared to the respective effort required in smaller corporations, due to the inexistence of the personal element. However an interesting solution proposed by Wagner and Schroeder (Wagner and Schroeder, 2010), is the initial introduction of the corporate wiki to small groups, with an already established a sense of trust, and then the broadening of its use to larger settings with more anonymous teams.

A final issue pertaining to the use of wikis in large-scale organizational settings refers to the collaboration among different departments within the same organization. More specifically, as mentioned in the examined literature, special attention should be paid in case only one, or a few, departments of the organization use the corporate wiki and the other departments do not, since this approach might result in inter-sectional collaboration problems and delays due to the differences introduced in the format of the produced documents.

5.3 Wikis supporting inter-organizational collaboration

Apart from the use of wikis in SMEs and large organizations, a number of interesting remarks can also be made on their use as facilitators of inter-organizational collaboration. Firstly, the reduced levels of cultural integration – among the members of different organizations – may have negative results on the final wiki outcome, especially in case that the collaborating organizations compete for funding. Moreover, if the wiki usage involves organizations from multiple countries, then the cultural differences among the geographically dispersed teams could also be significant. Therefore, the success of a wiki supporting inter-organizational collaboration also relies on finding means of fostering group identity, surpassing potential cultural or spatiotemporal differences and discovering common communication formats.

5.4 Wikis combined with other corporate solutions

In the examined studies, the implemented corporate wikis are often used either solely, or in combination with one of the existing solutions of the organization.

A typical pattern observed, is that corporate wikis tend to fully replace existing static intranet knowledge sharing solutions – such as HTML pages – or previously implemented centralized information management approaches, such as relational databases maintainable by a few individuals. This can be attributed to the fact that wikis are indeed more effective in supporting collaborative knowledge sharing within the organization and in involving more participants in this process.

However since wikis provide limited support over synchronous communication, it can be also observed that, in most of the cases examined, email was still used as the major communication channel even after the launch of the wiki. Nevertheless, the wiki usage was considered to be beneficial in this direction too, since it helped reduce the attachment sizes of the exchanged messages, while it also offered far more extended versioning support. Overall, it seems that wikis are also successful when used complementarily to other enterprise tools, since this a combination further supports the involved communication and collaboration activities of the organization (Majchrzak *et al.*, 2006, Richter and Koch, 2008). Integration of a new system, such as the wiki, to the existing tools of the organization also presents the benefit that users are already accustomed to the old tools and therefore they can get accustomed to the wiki more easily.

Thus, depending on the organizational process that the corporate wiki needs to serve, one may observe that it can function both solely and in combination with existing organizational solutions. What is important is to match the strengths of each available technology to the requirements of the organizational activity at hand and produce a solution that better addresses the corporate needs.

5.5 Trends and future research directions

A number of trends and future research directions can be deduced, based on the literature studies analyzed above.

5.5.1 Semantic corporate wikis

A first trend refers to the increasing use of semantic wikis in corporate environments. This usage pattern can be attributed to the fact that semantic wikis seem to be able to effectively address a number of issues typically related to wikis, such as navigation difficulties, loose structural support, laborious information retrieval and content of uncertain quality. It seems that semantic wiki functionalities, and especially the use of ontologies, can help address these issues by enhancing navigation experience – through tag supported navigation – and by facilitating information retrieval, through semantic querying. They can also be used to provide a better, yet still flexible, structural support and to help increase trust over the quality of the stored content, through the provision of collaborative annotation mechanisms.

5.5.2 Wikis in information systems development and third party interactions management

Two additional interesting trends refer to the use of wikis to support the processes of information systems development and corporate third party interactions.

On the one hand, the use of wikis in supporting the information systems development efforts of a corporation seems to be one of the most flourishing domains. The corporate wikis used in this domain were among the ones with the most variations from case to case, experimenting with a number of different features, techniques and organizational sub-processes. This observation can be mainly attributed to the fact that the users of a wiki supporting the process of information systems development are typically already familiar with the use of technology in general and thus, they can easily become accustomed to the newly introduced platform and fully benefit from the new characteristics that it can bring to their projects.

On the other hand, the use of wikis in supporting third party interactions is covered and analyzed by less research papers compared to other domains. Despite this, it seems that corporations invest significant efforts on launching wikis to support their relationship with customers, especially as far as marketing and advertising ventures are concerned. The fact that these corporate stories and experiments exist, combined with the limited number of existing research papers, provide a significant potential for research on this specific field. It would be thus interesting to see more publications analyzing real-world case studies of wikis supporting the above field and potentially approaching the subject through different viewing angles, such as studies with a marketing-research orientation or studies focusing more on the quantitative added value that this type of wikis can provide the enterprise with.

5.5.3. Open research issues

Apart from the aforementioned trends, a number of scientific issues regarding the use of wikis in corporate settings remain open and, as such, they could benefit from future research efforts. These include the need to measure the return on investment produced through the use of a corporate wiki, the identification of the base factors affecting its success, the development of a detailed framework for the selection of the most appropriate corporate wiki platform, as well as more technologically-oriented issues, such as the merging of the wiki with social networks, the enabling of its access through handheld devices, the development of flexible wiki analysis models

and the enhancement of the corporate wiki with a number of existing successful enterprise technologies.

From an organizational-strategy-oriented point of view, a first open issue refers to measuring the added value that an enterprise wiki can gain the enterprise. The accurate measurement of the return on investment (ROI) that organizational wikis have – potentially on differentiated organizational cases – is a factor critical to the management's decision to launch a corporate wiki project. As a consequence, a challenging research subject is the development of a framework of metrics, which will also take into consideration the underlying contextual factors – such as industry, functional area and scope of use, to assess the ROI stemming from enterprise wikis.

A second open area of research is the identification of the base assumptions that affect the success of corporate wikis. Specifically, field studies could be conducted – including interviews with enterprise wiki users but also with top management members – to identify the success factors that affect the sustainability of a corporate wiki. Findings from the organizational theory literature could then be used to analyze the results of these field studies and develop a framework of guidelines and best practices.

Another very challenging task for an enterprise is to select the appropriate wiki platform that matches its business goals and strategic objectives. In this paper, and based on the existing research literature, an initial attempt has been performed to identify a number of features that could affect such a decision. Future research could significantly expand this effort towards the development of more fine-grained, comprehensive frameworks for selecting the most suitable platform for a specific enterprise.

Apart from strategically oriented issues, a number of technically-oriented open issues, which need to be explored, can also be identified.

Firstly, research could focus on merging the wiki technology with other popular user involvement streams – such as corporate social networks – to benefit from the significant number of participation and information dissemination capabilities that the latter present, while keeping the relative, community-produced information in a structured format. Such an approach, is expected to benefit a number of different organizational tasks, which range from interaction with third parties – where the social network-wiki combination can be used to develop and diffuse collaborative marketing information – to organizational response in crisis situations, where this

combination can be used to speed up the process of identifying the necessary individuals who will contribute potential solutions to resolve a crisis incident.

An additional interesting open scientific area pertains to research on the field of enabling the use of wikis through handheld devices. Such an option is expected to significantly increase the number of wiki views and contributions, due to the further relaxation of spatiotemporal restrictions that it will offer corporate users. Sub-topics on this specific area could include research on accessibility and ergonomics, to facilitate user access to the wiki, as well as security, to enable corporate users share knowledge without compromising enterprise data confidentiality.

A third open issue refers to the development of wiki analysis tools and models, which will be not hardwired to the wiki database but they will rather allow customization and usability to facilitate different analysis needs on a variety of organizational granularity levels. Specifically, most of the current wiki analysis models and tools are bound to the underlying wiki engine, a fact which limits their usability on the often highly customized corporate wiki platforms. With initial research works already starting to emerge (Diaz and Puente, 2010), further research needs to be performed on the field of decoupling the analysis model processing (i.e. how the analysis model is processed, for instance through visualization techniques) from the way that this analysis model is obtained and populated. Such a decoupling would significantly facilitate the analysis of organizational wiki content across different platforms and help expand the diffusion, influence and usefulness of corporate wikis.

Finally, further research on the technological aspect of corporate wikis needs to be performed to enhance them with a number of features that are repeatedly requested throughout the relevant literature. These features include the demand for richer editing capabilities, the need for supporting more complex document formats, such as tables and Office documents, the combination of wikis with existing successful technologies, like enterprise search engines, as well as the request for better support over synchronous communication.

6. CONCLUSION

Corporate collaboration, as an important aspect of the effort that today's businesses make to be competitive in the global market, has been increasingly attracting the interest of both researchers and enterprises. Web 2.0 technologies present significant

prospective towards enhancing this type of collaboration, since they enhance the distributed collaboration potential of corporate units and individuals. Wikis – with their ability to facilitate collaborative content creation – are among the most prominent examples of the use of web 2.0 technologies in the corporate sector. In this survey we explore the effects that the wiki technology has on a variety of organizational processes, analyze the merits and concerns that stem out of its use and discuss potential solutions. Finally, based on the aforementioned related research literature analysis we provide a discussion over a variety of issues, such as the enablers and constraints of the wiki usage in corporate environments or the use of wikis in corporations of different size, and identify trends and future research directions on the field.

REFERENCES

Aguiar, A. & David, G., 2005. WikiWiki weaving heterogeneous software artifacts. *Proceedings of the 2005 international symposium on Wikis.* San Diego, California: ACM.

Al-Asmari, K. & Yu, L., 2006. Experiences in Distributed software development with wiki *International Conference on Software Engineering Research and Practice & Conference on Programming Languages and Compilers (SERP 2006)*, Las Vegas, Nevada, USA: CSREA Press, 293-389.

Alquier, L., Mccormick, K. & Jaeger, E., 2009. knowIT, a semantic informatics knowledge management system. *Proceedings of the 5th International Symposium on Wikis and Open Collaboration.* Orlando, Florida: ACM.

Angioni, M., Carboni, D., Pinna, S., Sanna, R., Serra, N. & Soro, A., 2006. Integrating XP project management in development environments. *J. Syst. Archit.,* 52**,** 619-626.

Anslow, C. & Riehle, D., 2007. Lightweight End-user Programming with Wikis. *Wikis for Software Engineering Workshop, WikiSym 2007 conference.*

Anslow, C. & Riehle, D., 2008. Towards End-User Programming with Wikis. *WEUSE IV'08.* Leipzig, Germany.

Auer, S., Jungmann, B. & Schönefeld, F., 2007. Semantic Wiki Representations for Building an Enterprise Knowledge Base. *Reasoning Web.* 330-333.

Augustine, S., 2005. *Managing Agile Projects*: Prentice Hall PTR.

Bambi, F., 2006. *Why media will embrace wikis* [online]. MarketWatch Available from: http://www.marketwatch.com/story/correct-why-media-will-embrace-wikis [Accessed October 12, 2010].

Bbc, 2010. *H2g2* [online]. http://www.bbc.co.uk/dna/h2g2 [Accessed September 12, 2010].

Bibsonomy, 2011. *BibSonomy* [online]. Knowledge and Data Engineering Group, University of Kassel, Germany. Available from: http://www.bibsonomy.org/ [Accessed January 11, 2011].

Bradshaw, P., 2007. Wiki Journalism: Are wikis the new blogs? *The Future of Newspapers Conference.* Cardiff University.
Bronk, C. & Smith, T., 2010. Diplopedia imagined: Building state's diplomacy wiki *Collaborative Technologies and Systems (CTS), 2010 International Symposium on*, 593-602.
Cabrera, A. & Cabrera, E.F., 2002. Knowledge-Sharing Dilemmas. *Organization Studies,* 23**,** 687-710.
Cammarata, V., 2007. Wikibilty of Innovation Oriented Workplaces - The CERN Case. Master Thesis. University of Lugano.
Campanini, S.E., Castagna, P. & Tazzoli, R., 2004. Platypus Wiki: a Semantic Wiki Wiki Web *1st Italian Semantic Web Workshop*, Ancona, Italy.
Challborn, C. & Reimann, T., 2004. *Wiki products: a comparison*, R47/0412.
Chau, T. & Maurer, F., 2004. Tool Support for Inter-team Learning in Agile Software Organizations. *Advances in Learning Software Organizations.* 98-109.
Chau, T. & Maurer, F., 2005. A case study of wiki-based experience repository at a medium-sized software company. *Proceedings of the 3rd international conference on Knowledge capture.* Banff, Alberta, Canada: ACM.
Corso, M. & Giacobbe, A., 2005. Building Communities of Practice that work: a case study based research. *The Sixth European Conference on Organizational Knowledge, Learning, and Capabilities.* Bentley College, Waltham, Massachusetts, USA
Cosmocode, 2011. *WikiMatrix* [online]. http://www.wikimatrix.org/ [Accessed January 10, 2011].
Creese, J., 2007. Web 2.0 / Business 2.0: New Web Technologies, Organisations and WCM. *2nd Annual Web Content Management Symposium, Organising Infinity: Web Content Management into the Future.* Queensland University of Technology, Gardens Point campus.
Deans, P.C., 2009. *Social Software and Web 2.0 Technology Trends* Hershey - New York: IGI Global.
Decker, B., Ras, E., Rech, J., Jaubert, P. & Rieth, M., 2007. Wiki-Based Stakeholder Participation in Requirements Engineering. *IEEE Softw.,* 24**,** 28-35.
Decker, B., Ras, E., Rech, J., Klein, B. & Hoecht., C., 2005. Self-organized Reuse of Software Engineering Knowledge Supported by Semantic Wikis *4th International Semantic Web Conference (ISWC 2005), Workshop on Semantic Web Enabled Software Engineering (SWESE)*, Galway, Ireland.
Dello, K., Nixon, L. & Tolksdorf, R., 2008. Extending the Makna Semantic Wiki to support workflows *3rd Semantic Wiki Workshop (SemWiki 2008) at the 5th European Semantic Web Conference (ESWC 2008)*, Tenerife, Spain.
Diaz, O. & Puente, G., 2010. Model-aware Wiki analysis tools: the case of HistoryFlow. *Proceedings of the 6th International Symposium on Wikis and Open Collaboration.* Gdansk, Poland: ACM.
Ding, X., Danis, C., Erickson, T. & Kellogg, W.A., 2007. Visualizing an enterprise Wiki. *CHI '07 extended abstracts on Human factors in computing systems.* San Jose, CA, USA: ACM.
Dorroh, J., 2005. Wiki: Don't Lose That Number, Despite the Los Angeles Times' fiasco, the interactive online tool holds promise for journalism. *American Journalism Review.*
Erickson, T., 2008. 'Social' systems: designing digital systems that support social intelligence. *AI Soc.,* 23**,** 147-166.

Eryilmaz, E., Cochran, M. & Kasemvilas, S., 2009. Establishing trust management in an open source collaborative information repository: an emergency response information system case study. *2009 Hawaii International Conference on System Sciences (HICSS)* Waikoloa, Big Island, Hawaii.

Fægri, T., Decker, B., Dingsøyr, T., Jaccheri, L., Lago, P., Muthig, D. & Van Vliet, H., 2005. Exploring Communities of Practice for Product Family Engineering. *Professional Knowledge Management.* 96-105.

Feng, X., Chen, W. & Feng, Y.Q., 2007. Wiki-based Knowledge Management In Small and Medium Projects. *The International Conference on Construction and Real Estate Management.*

Fuchs-Kittowski, F. & Kohler, A., 2005. Wiki communities in the context of work processes. *Proceedings of the 2005 international symposium on Wikis.* San Diego, California: ACM.

Garrahan, M., 2007. *Disney's launches 'wiki' website aimed at parents* [online]. http://www.ft.com/cms/s/0/906c5ef0-d1d2-11db-b921-000b5df10621.html#axzz1BJBIsZcM [Accessed October 15, 2010].

Ghali, A.E., Tifous, A., Buffa, M., Giboin, A. & Dieng-Kuntz, R., 2007. Using a Semantic Wiki in Communities of Practice. *Proceedings of the 2nd International Workshop on Building Technology Enhanced Learning solutions for Communities of Practice.* Crete, Greece.

Giles, J., 2007. Key biology databases go wiki. *Nature,* 445**,** 691-691.

Giordano, R., 2007. An investigation of the use of a wiki to support knowledge exchange in public health. *Proceedings of the 2007 international ACM conference on Supporting group work.* Sanibel Island, Florida, USA: ACM.

Grudin, J. & Poole, E.S., 2010. Wikis at work: success factors and challenges for sustainability of enterprise Wikis. *Proceedings of the 6th International Symposium on Wikis and Open Collaboration.* Gdansk, Poland: ACM.

Hansberger, J., Tate, A., Moon, B. & Cross, R., 2010. Cognitively Engineering a Virtual Collaboration Environment for Crisis Response. *2010 ACM Conference on Computer Supported Cooperative Working (CSCW 2010).* Savannah, Georgia, USA.

Happel, H.J., Maalej, W. & Panagiotou, D., 2007. *Tightening knowledge sharing in distributed software communities by applying semantic technologies*.

Hasan, H. & Pfaff, C.C., 2006. The Wiki: an environment to revolutionise employees' interaction with corporate knowledge. *Proceedings of the 18th Australia conference on Computer-Human Interaction: Design: Activities, Artefacts and Environments.* Sydney, Australia: ACM.

Hearn, G., Foth, M. & Gray, H., 2009. Applications and implementations of new media in corporate communications: An action research approach. *Corporate Communications: An International Journal,* 14**,** 49 - 61.

Heineke, J., Meile, L., Liu, L.B. & Davies, J., 2010. Project Flip: A Project Management Case/Exercise Experience. *Decision Sciences Journal of Innovative Education,* 8**,** 113-127.

Helen Hasan, Joseph a Meloche, Charmaine C Pfaff & David Willis, 2007. Beyond Ubiquity: Co-creating Corporate Knowledge with a Wiki. *International Conference on Mobile Ubiquitous Computing, Systems, Services and Technologies, 2007. UBICOMM '07.* . 35-40.

Helpdesks.Com, 2011. *Help Desk Software Comparison* [online]. http://www.helpdesks.com/chart.htm [Accessed January 11, 2011].

Hester, A.J., 2010. Increasing collaborative knowledge management in your organization: characteristics of wiki technology and wiki users. *Proceedings of the 2010 Special Interest Group on Management Information System's 48th annual conference on Computer personnel research on Computer personnel research.* Vancouver, BC, Canada: ACM.

Hilska, K., 2008. How wiki-intranet changes internal communication? *The 11th European Conference of Medical and Health Libraries, EAHIL 2008.*

Hoimyr, N. & Jones, P., 2007. Wikis supporting PLM and Technical Documentation. *Product Data Technology (PDT) Europe 2007 conference.*

Holtzblatt, L.J., Damianos, L.E. & Weiss, D., 2010. Factors impeding Wiki use in the enterprise: a case study. *Proceedings of the 28th of the international conference extended abstracts on Human factors in computing systems.* Atlanta, Georgia, USA: ACM.

Hu, C., Zhao, Y. & Zhao, X., 2007. Wiki-based Knowledge Sharing in A Knowledge-Intensive Organization. *Integration and Innovation Orient to E-Society Volume 2.* 18-25.

Hupfer, S., Cheng, L.T., Ross, S. & Patterson, J., 2005. Reinventing Team Spaces for a Collaborative Development Environment. *CM CHI Conference on Human Factors in Computing Systems, "Beyond Threaded Conversation" Workshop.* Portland, OR

Jang, H.-C., Lien, Y.-N. & Tsai, T.-C., 2009. Rescue information system for earthquake disasters based on MANET emergency communication platform. *Proceedings of the 2009 International Conference on Wireless Communications and Mobile Computing: Connecting the World Wirelessly.* Leipzig, Germany: ACM.

Jianyuan, S. & Jin, C., 2005. Research on the sharing approaches and organizational culture of enterprise tacit knowledge. *Technology Economy***,** 27-29.

Johnson, N.F., Clarke, R.J. & Herrington, J., 2008. The potential affordances of enterprise wikis for creating community in research networks. *Emerging Technologies Conference.* San Jose, CA, U.S.A.

Kankanhalli, A., Tan, B.C. & Wei, K.K., 2005. Contributing Knowledge to Electronic Knowledge Repositories: An Empirical Investigation. *MIS Quarterly,* 29**,** 113-143.

Klein, R. & Smith, M., 2008. Pursuing the peak of excellence: Wiki as a knowledge base. *Proceedings of the 36th annual ACM SIGUCCS conference on User services conference.* Portland, OR, USA: ACM.

Klein, R., Smith, M. & Sierkowski, D., 2007. Reduce response time: get "hooked" on a wiki. *Proceedings of the 35th annual ACM SIGUCCS conference on User services.* Orlando, Florida, USA: ACM.

Kolodzy, J., 2006. *Convergence Journalism: Writing and Reporting Across the News Media*: Rowman & Littlefield Publishers.

Kumar, S., 2009. Building a Learning Community using Wikis in Educational Technology Courses. *In*: I. Gibson, R. Weber, K. Mcferrin, R. Carlsen & D.A. Willis *Society for Information Technology & Teacher Education International Conference 2009*, Charleston, SC, USA: AACE, 2848-2852.

Labview, 2011. *LabVIEW* [online]. National Instruments. Available from: http://www.ni.com/labview/ [Accessed January 09, 2011].

Lave, J. & Wenger, E., 1991. *Situated Learning: Legitimate Peripheral Participation (Learning in Doing: Social, Cognitive and Computational Perspectives)* Cambridge: Cambridge University Press.

Layman, L., Williams, L., Damian, D. & Bures, H., 2006. Essential communication practices for Extreme Programming in a global software development team. *Information and Software Technology,* 48**,** 781-794.

Leshed, G., Haber, E.M., Matthews, T. & Lau, T., 2008. CoScripter: automating & sharing how-to knowledge in the enterprise. *Proceeding of the twenty-sixth annual SIGCHI conference on Human factors in computing systems.* Florence, Italy: ACM.

Levine, R., 2006. *New Web Sites Seeking Profit in Wiki Model* [online]. http://www.nytimes.com/2006/09/04/technology/04wiki.html?_r=1 [Accessed September 15, 2010].

Li, Q., Feng, L., Pei, J., Wang, S., Zhou, X., Zhu, Q.-M., Zhao, Y., Zhang, Y. & Xing, C., 2009. Let Wiki Be More Powerful and Suitable for Enterprises with External Program. *Advances in Data and Web Management.* Springer Berlin / Heidelberg, 671-676.

Liang, P., Jansen, A. & Avgeriou, P., 2009. Sharing architecture knowledge through models: Quality and cost. *Knowl. Eng. Rev.,* 24**,** 225-244.

Liang, T.-P. & Tanniru, M.R., 2007. Special Section: Customer-Centric Information Systems *Journal of Management Information Systems,* 23**,** 9-15.

Liccardi, I., Davis, H. & White, S., 2007. *CAWS: a wiki system to improve workspace awareness to advance effectiveness of co-authoring activities* New York, NY, USA: ACM Press.

Liccardi, I., Davis, H., White, S. & Southampton, H., 2008. CAWS: Visualizing awareness to improve the effectiveness of co-authoring activities. *Special issue of Collaborative Computing in IEEE Distributed Systems Online*.

Lieberman, H., Paternò, F., Wulf, V. & Klann, M., 2006. End-User Development: An Emerging Paradigm. *End User Development.* Springer Netherlands, 1-8.

Lio, E.D., Fraboni, L. & Leo, T., 2005. TWiki-based facilitation in a newly formed academic community of practice. *Proceedings of the 2005 international symposium on Wikis.* San Diego, California: ACM.

Liu, S.B., Palen, L., Sutton, J., Hughes, A. & Vieweg, S., 2008. In Search of the Bigger Picture: The Emergent Role of On-Line Photo Sharing in Times of Disaster. *Proceedings of the Conference on Information Systems for Crisis Response & Management (ISCRAM).* Washington, DC, USA.

Lohmann, S., Riechert, T., Auer, A. & Ziegler, J., 2008. Collaborative Development of Knowledge Bases in Distributed Requirements Elicitation. *In*: W. Maalej & B. Brγógge *Software Engineering (Workshops)*GI, 22--28.

Lotufo, R.A., Machado, R.C., Korbes, A. & Ramos, R.G., 2009. Adessowiki on-line collaborative scientific programming platform. *Proceedings of the 5th International Symposium on Wikis and Open Collaboration.* Orlando, Florida: ACM.

Louridas, P., 2006. Using Wikis in Software Development. *IEEE Software,* 23**,** 88-91.

Lykourentzou, I., Papadaki, K., Vergados, D.J., Polemi, D. & Loumos, V., 2010. CorpWiki: A self-regulating wiki to promote corporate collective intelligence through expert peer matching. *Information Sciences,* 180**,** 18-38.

Majchrzak, A., Wagner, C. & Yates, D., 2006. Corporate wiki users: results of a survey. *Proceedings of the 2006 international symposium on Wikis.* Odense, Denmark: ACM.

Mason, B. & Thomas, S., 2008. *A Million Penguins Research Report* Leicester, UK.

Mendeley, 2011. *Academic reference management software for researchers - Mendeley* [online]. http://www.mendeley.com/ [Accessed January 10, 2011].

Mestad, A., Myrdal, R., Dingsoyr, T. & Dyba, T., 2007. Building a Learning Organization: Three Phases of Communities of Practice in a Software Consulting Company. *Proceedings of the 40th Annual Hawaii International Conference on System Sciences.* IEEE Computer Society.

Mindstorms, 2011. *Lego MindStorms* [online]. Lego. Available from: http://mindstorms.lego.com/en-us/Default.aspx [Accessed January 09, 2011].

Mohamad Nordin, N. & Klobas, J., 2010. Wikis as collaborative learning tools for knowledge sharing: Shifting the education landscape. *In*: Z.W. Abas, I. Jung & J. Luca *Global Learn Asia Pacific 2010*, Penang, Malaysia: AACE, 331-340.

Moore, R., Reff, K., Graham, J. & Hackerson, B., 2007. Scrum at a Fortune 500 Manufacturing Company *AGILE 2007*, Washington, DC 175-180.

Munson, S.A., 2008. Motivating and Enabling Organizational Memory with a Workgroup Wiki. *The International Symposium on Wikis, WikiSym '08* Porto, Portugal.

Neumann, G. & Erol, S., 2009. From a Social Wiki to a Social Workflow System. *Business Process Management Workshops.* 698-708.

Neus, A., 2001. Managing Information Quality in Virtual Communities of Practice *6th Internation Conference on Information Quality at MIT*, Boston, MA.

Nielsen, P.A. & Dolog, P., 2008. *State-of-the-art on software project management knowledge*.

Nonaka, I. & Takeuchi, H., 1995. *The Knowledge-Creating Company : How Japanese Companies Create the Dynamics of Innovation* New York: Oxford University Press.

Noveck, B., 2009a. WIKI government: a public sector innovation. *Proceedings of the 10th Annual International Conference on Digital Government Research: Social Networks: Making Connections between Citizens, Data and Government.* Digital Government Society of North America.

Noveck, B.S., 2009b. *Wiki Government How Technology Can Make Government Better, Democracy Stronger, and Citizens More Powerful*: Brookings Institution Press.

Nuschke, P. & Jiang, X., 2007. A Framework for Inter-organizational Collaboration Using Communication and Knowledge Management Tools. *Online Communities and Social Computing.* 406-415.

O'leary, D.E., 2008. Wikis: 'From Each According to His Knowledge'. *Computer,* 41**,** 34-41.

Osterloh, M. & Frey, B.S., 2000. Motivation, Knowledge Transfer, and Organizational Forms. *Organization Science,* 11**,** 538-550.

Pallot, M., Ruland, R., Traykov, S. & Kristensen, K., 2006. Integrating Shared Workspace, Wiki and Blog Technologies to Support Interpersonal Knowledge Connection. *15th International Conference on Concurrent Enterprising.* Leiden,Netherlands.

Petter, S. & Vaishnavi, V., 2008. Facilitating experience reuse among software project managers. *Inf. Sci.,* 178**,** 1783-1802.

Plotnick, L., Ocker, R., Hiltz, S. & Rosson, M.B., 2008. Leadership Roles and Communication Issues in Partially Distributed Emergency Response Software Development Teams: A Pilot Study. *Proceedings of the Proceedings of the 41st Annual Hawaii International Conference on System Sciences.* IEEE Computer Society.

Raman, M., 2006. Wiki Technology as A "Free" Collaborative Tool within an Organizational Setting. *Information Systems Management,* 23**,** 59 - 66.

Ramos, M. & Piper, P.S., 2006. Letting the grass grow: grassroots information on blogs and wikis. *Reference Services Review,* 34**,** 570-574.

Raymond, L. & Bergeron, F., 2008. Project management information systems: An empirical study of their impact on project managers and project success. *International Journal of Project Management,* 26**,** 213-220.

Rech, J., Bogner, C. & Haas, V., 2007. Using Wikis to Tackle Reuse in Software Projects. *IEEE Softw.,* 24**,** 99-104.

Regolini, A., Berger, F., Ober, E.J. & Dorren, L., 2008. From tailored databases to Wikis: using emerging technologies to work together more efficiently. *Interdisciplinary Journal of Information, Knowledge and Management,* 3**,** 103-113.

Richter, A. & Koch, M., 2008. The enterprise 2.0 story in Germany so far *International Conference on Computer-Supported Collaborative Work 2008, Workshop "What to expect from Enterprise 3.0: Adapting Web 2.0 to Corporate Reality".* San DIego California, USA.

Sauer, I.M., Bialek, D., Efimova, E., Schwartlander, R., Pless, G. & Neuhaus, P., 2005. "Blogs" and "Wikis" Are Valuable Software Tools for Communication Within Research Groups. *Artificial Organs,* 29**,** 82-83.

Schaffert, S., 2006. IkeWiki: A Semantic Wiki for Collaborative Knowledge Management *1st International Workshop on Semantic Technologies in Collaborative Applications (STICA)*, Manchester, U.K.

Schaffert, S., Bischof, D., Burger, T., Gruber, A., Hilzensauer, W. & Schaffert, S., 2006. Learning with Semantic Wikis. *Proceedings of the First Workshop on Semantic Wikis - From Wiki To Semantics (ESWC 2006).* Budva, Montenegro

Schulz, J., 2009. *Company-Wiki as a knowledge transfer instrument for reducing the shortage of skilled workers*.

Shepherd, E., 2008. Documenting the Mozilla Project - A Practical Example of Wikis in Open Source Documentation. *The Third Workshop on Wikis for Software Engineering, WikiSym 2008 conference* Porto, Portugal.

Shiva, S.G. & Shala, L.A., 2008. Using Semantic Wikis to Support Software Reuse. *Journal of Software,* 3**,** 1-8.

Silveira, C., Faria, J.P., Aguiar, A. & Vidal, R., 2005. Wiki based requirements documentation of generic software products *10th Australian Workshop on Requirements Engineering (AWRE)*, Melbourne, Australia, 42-51.

Sketchup, 2011. *Google SketchUp* [online]. http://sketchup.google.com/ [Accessed January 11, 2011].

Socialtext, 2010. [online]. http://www.socialtext.com/customers/ [Accessed August 19, 2010].

Solis, C., Ali, N. & Babar, M., 2009. A Spatial Hypertext Wiki for Architectural Knowledge Management. *ICSE Workshop on Wikis for Software Engineering.* Vancouver, Canada.

Sommerville, I. & Sawyer, P., 1997. *Requirements Engineering: A Good Practice Guide*: John Wiley & Sons, Inc.

Stenmark, D., 2005. Knowledge sharing through increased user participation on a corporate intranet. *OKLC 2005.* Bentley College, Waltham, Massachusetts, USA.

Stubblefield, W.A. & Carson, T.L., 2007. Software design and engineering as a social process. *CHI '07 extended abstracts on Human factors in computing systems.* San Jose, CA, USA: ACM.

Suggs, R. & Lewis, B., 2007. Enterprise simulation - a practical application in business planning *Simulation Conference, 2007 Winter*, 205-209.
Thomson.Reuters, 2011. *EndNote* [online]. http://www.endnote.com/ [Accessed January 11, 2011].
Underwood, S., 2010. Improving disaster management. *Communications of the ACM,* 53**,** 18-20.
Van De Walle, B., Van Den Eede, G. & Muhren, W., 2009. Humanitarian Information Management and Systems. *Mobile Response.* 12-21.
Wagner, C. & Majchrzak, A., 2007. Enabling Customer-Centricity Using Wikis and the Wiki Way. *J. Manage. Inf. Syst.,* 23**,** 17-43.
Wagner, C. & Schroeder, A., 2010. Capabilities and Roles of Enterprise Wikis in Organizational Communication. *Technical Communication,* 57**,** 68-89.
Wasko, M.M. & Faraj, S., 2005. Why should I share? Examining social capital and knowledge contribution in electronic networks of practice. *MIS Quarterly***,** 35-37.
Watkins, J. & Rodriguez, M., 2008. A Survey of Web-Based Collective Decision Making Systems. *Evolution of the Web in Artificial Intelligence Environments.* 243-277.
Wenger, E., Mcdermott, R. & Snyder, W., 2002. *Cultivating Communities of Practice: A Guide to Managing Knowledge*: Harvard Business School Press.
Wenger, E., White, N. & Smith, J., 2009. *Digital Habitats; stewarding technology for communities* Portland, OR: CPsquare.
White, C., Plotnick, L., Addams-Moring, R., Turoff, M. & Hiltz, S.R., 2008. Leveraging a Wiki to EnhanceVirtual Collaboration in the Emergency Domain *Hawaii International Conference on System Sciences, Proceedings of the 41st Annual*, 322-322.
White, C., Plotnick, L., Kushma, J., Hiltz, S.R. & Turoff, M., 2009. An Online Social Network for Emergency Management. *Proceedings of the 6th International ISCRAM Conference.* Gothenburg, Sweden.
Wiebrands, C., 2006. Collaboration and communication via wiki: The experience of Curtin University Library and Information Service *Australian Library and Information Association 2006 Biennial Conference* Perth, Australia.
Wikipedia, 2011a. *Comparison of reference management software* [online]. http://en.wikipedia.org/wiki/Comparison_of_reference_management_software [Accessed January 11, 2011].
Wikipedia, 2011b. *Comparison of Wiki Farms* [online]. http://en.wikipedia.org/wiki/Comparison_of_wiki_farms [Accessed January 10, 2011].
Wikipedia, 2011c. *Comparison of wiki software* [online]. http://en.wikipedia.org/wiki/Comparison_of_wiki_software [Accessed January 10, 2011].
Wikitravel, 2010. [online]. http://wikitravel.org/en/Main_Page [Accessed August 10, 2010].
Wu, D., Yang, D., Koolmanojwong, S. & Boehm, B.W., 2009. Experimental Evaluation of Wiki Technology and the Shaper Role in Rapid Interdisciplinary Requirements Negotiation. *Hawaii International Conference on System Sciences.*
Xiao, W., Chi, C. & Yang, M., 2007. On-line collaborative software development via wiki. *Proceedings of the 2007 international symposium on Wikis.* Montreal, Quebec, Canada: ACM.

Yang, D., Wu, D., Koolmanojwong, S., Brown, A.W. & Boehm, B.W., 2008. WikiWinWin: A Wiki Based System for Collaborative Requirements Negotiation. *Proceedings of the Proceedings of the 41st Annual Hawaii International Conference on System Sciences.* IEEE Computer Society.

Yates, D., Wagner, C. & Majchrzak, A., 2010. Factors affecting shapers of organizational wikis. *Journal of the American Society for Information Science and Technology,* 61**,** 543-554.

Zheng, X.S., Sapundshiev, I. & Rauschenberger, R., 2007. *WikiTable: A New Tool for Collaborative Authoring and Data Management* Germany: Springer - Verlang.