Aalto University
School of Economics

Improving the usability of wikis: Case IT product team of Company X

Information Systems Science

Master's thesis

Antti Karhu

2011

Department of Information and Service Economy
Aalto University
School of Economics

AALTO UNIVERSITY SCHOOL OF ECONOMICS ABSTRACT
Information and Service Management
Master's thesis
Antti Karhu

Improving the usability of wikis

Purpose of the study

This thesis seeks to increase understanding of wiki usability problems and to find possible ways to improve the usability of wikis. The effect that usability improvements have on wiki use will be evaluated in an empirical study using a theoretical framework formed during in this thesis. In addition, a better understanding of the wiki way of working will be sought.

Methodology:

A literature review of relevant research will be done. The focus is on findings regarding the technical properties of wikis, wiki implementation issues and use of wikis in organizations as well as findings about wiki usability issues and ways to improve usability of wikis. Based on the findings of the literature review, two new theoretical frameworks will be built.

To test the validity of the frameworks, empirical research is conducted at a case company. In the empirical part, the Action Design Research Methodology is utilized. Usability of a wiki used by the case company is evaluated and improvements to found problems are implemented. The effect of the implemented improvements on wiki use at the case company is then observed for five months by following statistics of wiki use and interviewing the users of the wiki.

Findings

The technical properties of wikis that are essential to the wiki way of working were found, and understanding of wiki usability issues was increased. Two frameworks were formed based on research findings of the study. In the frameworks it was proposed that the continued use of a wiki with low usability leads to lost productivity. It was also proposed that by improving the usability of a wiki, it is possible to get more users to embrace the wiki way of working, leading to increased productivity.

The validity of the proposals was tested in the case company. The proposals were found to be true. It was shown that it is possible to increase people's willingness to contribute to a wiki by improving its usability. This was also shown to lead to increased productivity compared to the situation before the introduction of the improvements. It was also found that templates and user interface improvements are good methods to increase usability and they do not disrupt the wiki way of working. They methods can also be applied to other information systems.

Keywords:

Wikis, tagging, collaboration, web 2.0, enterprise 2.0, co-creation, usability, user experience, Action Design Research

AALTO-YLIOPISTON KAUPPAKORKEAKOULU TIIVISTELMÄ
Information and Service Management
Pro Gradu tutkielma
Antti Karhu

Wikien käytettävyyden parantaminen

Tutkimuksen tarkoitus

Tämän tutkimuksen tarkoituksena on lisätä ymmärrystä wikien käytettävyysongelmista ja löytää mahdollisia tapoja parantaa wikien käytettävyyttä. Wikin käytettävyysparannusten vaikutusta käyttäjien wikissä työskentelyyn arvioidaan empiirisessä tutkimuksessa käyttäen tutkielmassa luotua teoreettista viitekehystä. Lisäksi yritetään löytää parempi ymmärrys käsitteeseen työn tekeminen wikien avulla (wiki way of working).

Tutkimuksen toteutus

Tutkimuksessa tehdään kirjallisuuskatsaus relevantista tutkimuksesta. Kohteena ovat löydökset wikien teknisistä ominaisuuksista, wikien käyttöönottoon liittyvistä asioista ja wikien käytöstä organisaatiossa, sekä löydökset wikien käytettävyysongelmista että tavoista parantaa wikien käytettävyyttä. Löydösten pohjalta rakennetaan kaksi uutta teoreettista viitekehystä.

Viitekehysten paikkansapitävyys testataan suorittamalla empiirinen tutkimus kohdeyrityksessä. Empiirisessä osassa käytetään Action Design Research metodologiaa. Yrityksessä käytetyn wikin käytettävyyttä arvioidaan, ja löydettyihin ongelmiin tehdään parannuksia. Tehtyjen parannusten vaikutusta wikien käyttöön yrityksessä tarkkaillaan viiden kuukauden ajan seuraamalla tilastoja wikin käytöstä sekä haastattelemalla wikin käyttäjiä.

Tutkimuksen tulokset

Wikien tekniset ominaisuudet, jotka ovat keskeisiä työn tekemisessä wikien avulla, löydettiin, ja saavutettiin parempi ymmärrys wikien käytettävyydestä. Kaksi teknistä viitekehystä laadittiin kirjallisuuskatsauksen löydösten pohjalta. Viitekehyksissä ehdotettiin että käytettävyydeltään alhaisten wikien käytön jatkaminen johtaa heikompaan tuottavuuteen. Ehdotettiin myös, että wikien käytettävyyttä parantamalla on mahdollista saada useampia käyttäjiä osallistumaan työn tekemiseen wikeissä, joka johtaa tuottavuusparannuksiin.

Ehdotusten paikkansapitävyys testattiin kohdeyrityksessä ja ne havaittiin paikkansapitäviksi. Osoitettiin, että on mahdollista lisätä käyttäjien halukkuutta osallistua wikeissä työn tekemiseen parantamalla wikien käytettävyyttä. Tämän osoitettiin myös johtavan parempaan tuottavuuteen verrattuna tilanteeseen ennen parannusten tekoa. Havaittiin myös, että sivupohjat ja käyttöliittymän parannukset ovat hyviä keinoja parantaa käytettävyyttä, eivätkä ne haitaa wikin keskeisiä ominaisuuksia. Näitä keinoja voidaan käyttää myös muissa tietojärjestelmissä.

Avainsanat:
Wikit, taggaus, kollaboraatio, web 2.0, enterprise 2.0, yhdessä tekeminen, käytettävyys, käyttökokemus, Action Design Research

Table of Contents

1. INTRODUCTION

1.1 Background information

The research was conducted at a department in the IT organization of a large globally operating company. The department performs software development and technical support for certain IT systems used by the company. The team began using wikis in November 2009, and this research was done a year later.

1.2 Motivation

Wikis have been found to be an excellent tool for collaboration. The author studied the Enterprise 2.0 tools used at the case company during summer 2010 and found that the wiki used by the company was not user friendly. It was for example not easy to add a new page and information seemed to be scattered across the entire wiki, making it difficult to find. In addition to the usability findings, the employees of the company seemed unwilling to do actual work in the wiki itself. Both of these findings were later confirmed by the employees themselves. The author then began to consider whether these issues are linked: Would it be possible to increase employees' willingness to use a wiki as a collaboration tool by fixing the usability problems?

1.3 Explanation of the research problem

Many wiki usability problems are mentioned in wiki research. Proposals of how to fix some of these problems can also be found from wiki and also general IS research. However, only a little research about wiki usability in general has been done and research on how wiki usability affects actual wiki use is especially lacking: No research about what effect improving the usability of an existing wiki has on its use was found. In this thesis it is thus investigated if resolving wiki usability problems and thus improving its usability will have an effect on wiki use. The main research question is:

- Can the willingness of employees to adopt the wiki way of working be increased by improving the usability of an existing wiki?

Due to the unique nature of wikis, which will be explained later in detail, it also needs to be investigated whether or not the usability enhancements undermine the wiki way of working. As there does not seem to be any widely accepted definition of the wiki way of working, there is also a need to seek more understanding of it, which this research will also focus on. Thus additional other research questions are as follows:

- Can the usability of a wiki be improved without sacrificing the unique technical properties of the wiki?
- What are the unique properties in wikis that enable the wiki way of working and can it be defined?

1.4 Research method and scope of the research

A literature review will be done on relevant recent about wikis. The goal is to investigate findings regarding the technical properties of wikis, wiki implementation issues and use of wikis in organizations. A special emphasis will be placed on findings about wiki usability issues and mentions about ways to improve usability of wikis. Based on the findings of the literature review, two frameworks will be built.

The second part of the research is an empirical research done at the case company using the Action Design Research (ADR) method. The aim of the empirical investigation is to test the validity of the framework by analyzing the current use of wikis and implementing found usability improvements and measuring their possible effects on wiki use based on statistical observations and interviews with the users of the wiki. The scope of the empirical part is limited to two teams being observed and only usability issues are investigated.

1.5 Limitations

Due to the limited time available to do the thesis, the implanted usability improvements had to be done on a small scale. As a result, only some of the found wiki usability improvement methods could not be implemented in the time available. This also led to the ADR method, which is designed to include multiple phases, being limited to only two phases.

The framework formed in this study was also only tested at a single department at the case of company, although it was tested on two teams which consisted of different people. Time limitations also reduced the ability to determine how much of an effect the improvements that were done in the empirical part of the study have on longer term.

Although efficient use of wikis is often associated with presence of specific organizational factors such as a collaborative culture, due to the limited scope of this research these factors were not investigated in the empirical part of this thesis

1.6 Structure of the thesis

The first part of the thesis is a literature review, consisting of chapters two, three and four. Chapter two contains an introduction to the wiki technology. In chapter three, general research findings related to wikis will be reviewed. Chapter four focuses on research related to usability of wikis, including specific wiki usability problems found and possible solutions to fix them.

The second part focuses on theory, in chapter five. The theories used to research wikis will be reviewed. As a result of not finding a suitable theory for the empirical part, two new frameworks about issues related to improving the usability of wikis will be devised based on what was found about wiki usability issues and also partially based on previous IS theories.

The third part of the thesis is chapter six, which is focused on the empirical research done, which consists of two phases. It also includes an explanation of the research method used, Action Design Research.

To conclude the thesis, chapter seven summarizes the lessons learned from the study.

2. INTRODUCTION TO WIKIS

Wikis belong to a new type of Information Systems, which have been categorized as Enterprise 2.0 tools (McAfee, 2006). While wikis as well as other Enterprise 2.0 tools appear very simple at first, they can actually radically change the way work is being done. This chapter contains a brief introduction to Enterprise 2.0 as well as information about wikis in general.

2.1 Introduction to Enterprise 2.0

The term Enterprise 2.0 was first coined by Andrew McAfee in 2006 (McAfee, 2006). McAfee states that the Enterprise 2.0 technologies allow companies to engage in emergent collaboration to create knowledge by using social software that is easy to use. These technologies should especially benefit large companies as according to McAfee Enterprise 2.0 benefits from the network effect. The original definition of an Enterprise 2.0 information system included six key components that the system needed to have, referred to as SLATES. Wikis include all the components of SLATES:

- *Search* can be used to find relevant information
- *Links* are used to provide structure to the information
- *Authoring* allows information to be constantly changing as everyone can contribute
- *Tags* can be used to collaboratively structure information, resulting in folksonomies
- *Extensions* allow the automation of the information categorization process
- *Signals* enable users to follow what is going on in the system with for example RSS feeds

A newer definition for Enterprise 2.0 by Frappaolo & Keldsen attempts to define it further as "A system of Web-based technologies that provide rapid and agile collaboration, information sharing, emergence, and integration capabilities in the extended enterprise." (Frappaolo, et al., 2008). Collaboration is a key element in Enterprise 2.0. Baggs and Schmitt describe it as planning, making decisions, solving problems, setting goals, assuming responsibility and working together, as well as communicating, and coordinating openly (Baggs, et al., 2007).

Tapscott argues that Enterprise 2.0 is an integral part of a new "age of collaboration" that is emerging for companies. According to him, companies need to enhance collaboration on all levels. The levels, Tapscott states, are collaboration among things, employees, silos, firms and collaboration globally. He argues that Enterprise 2.0 is also the enabler to achieve collaboration with and among stakeholders globally. Tapscott claims that the key enabling issue of Enterprise 2.0 in achieving the global collaboration level is that Enterprise 2.0 uses the Internet as medium to enhance the richness in the ways things, people and firms work together. (Tapscott, 2006).

2.2 Description of wiki technology

While Wikipedia, the online encyclopedia, is arguably the most prominent example of a wiki, the technology itself is not meant just for building encyclopedias. Wikis can be referred to both as collaborative virtual working spaces and at the same time places to store information to (Phuwanartnurak, 2009). The word *wiki* itself is Hawaiian and it means quick (Cunningham, et al., 2001). According to Wagner, a wiki is unique both as a technology and in the way that users actually use it. (Wagner, 2004)

In technical sense, a wiki is software that is usually installed on a server that is connected to the internet. (Bairstow, 2003). It can also be installed behind a firewall on a company intranet (Buffa, 2006). Ward Cunningham, the inventor of the wikis, refers to wikis as being the "the simplest online database that could possibly work". What makes wikis special is that content can be edited, organized and even deleted by the users: Every wiki page has an edit button, which opens up the wiki page in editable form, with changes made appearing immediately after they are saved by the user. By allowing everyone to alter anything enables wiki contributors to collaborate and to create content interactively. The contributors can edit content in either real time or asynchronously. Leuf & Cunningham claim this makes the wiki interaction similar to discussion. (Cunningham, et al., 2001).

The original wiki was intended to contain as simple data as possible, so that everyone could visit the wiki with any web browser from anywhere. Simplicity was required because in 1995 many web browsers were quite limited. Because of this, the focus of the original wiki was on creating pure text instead of allowing elaborate formatting. Wiki pages could originally be created only by

using wiki markup. Wiki markup consists of commands that can be used to format the content of wiki pages. (Cunningham, et al., 2001). Adding simple text requires no additional commands, but all additional formatting functionality does, reflecting Cunningham's vision.

Another original wiki specialty is the use of hyperlinks to create content. In the original wiki, links were defined using embedded capitals, two words written together with capital letters. If a page that a link points to did not exist in the wiki, the link had a question mark next to it. Clicking on the question mark made it possible to create a new page. By only using links to create new pages meant that every page in the wiki would be connected to one another. (Cunningham, et al., 2001). Users were also able to determine the relationships between the documents in the wiki dynamically. (Hasan, et al., 2006). In later wikis, alternative means to create links between pages and to add new pages to the wiki have also been developed (Lih, 2009) but the original way also still exists.

Wikis also have other common features, such as revision control. It means that whenever a wiki page is changed, a new revision of it is stored. (VanDeursen, et al., 2002) It is possible to see the changes made between revisions and also revert back to an older revision of the page. (Pfaff, 2006). Most wikis can also notify users of changes to wiki pages, either by e-mail or RSS feeds (Louridas, 2006). This allows users to follow and monitor the activity occurring in the wiki without visiting the wiki itself.

2.3 Wiki platforms

A wiki platform is the system that the wiki is actually built on. There are many different wiki platforms available. Notable platforms include Mediawiki, which is for example used by Wikipedia. (Wikimedia, 2010) Another popular platform is TWiki, a structured wiki application that is used by many companies. These companies include the case company of this thesis as some well known companies, such as IBM and Motorola. (Thoeny, 2010). What is notable about the popular Mediawiki and Twiki platforms is that they are being developed as open source application. There are commercial wiki platforms too, such as a version of TWiki that includes customizations for companies. Socialtext (Socialtext, 2010) and Confluence (Atlassian, 2010) are

examples of wikis that exists only as commercial products. Confluence can also be installed on top of SharePoint, a popular basis for company intranets.

Current wiki platforms offer advanced functionalities, such as inclusion of tables, images and other multimedia files in wiki documents. Some of these, such as tables, are included in the contents of the wiki document. Others, such as images and other multimedia files are included as attachments that cannot be edited by editing the wiki document itself. There are also WYSIWYG editors available that enable users to edit and create documents without knowledge of wiki markup. Wikis have thus evolved significantly compared to the original wiki.

The popular open source wikis, TWiki and Mediawiki, have attracted developers that have created small applications, commonly referred to as plug-ins, which can be used to add advanced functionalities to the wiki (Wikimedia, 2009), (Thoeny, 2010). This advanced functionality varies greatly, from being able to use text boxes on pages to add comments (Gutman, 2010) to being able to perform spreadsheet calculations in wiki documents (Thoeny, 2010). Also Cunningham, the inventor of wikis, later wrote some statistics plugins for the original wiki platform (Cunningham, et al., 2001). While plugins add to the wikis' appeal as a collaboration tool, they also introduce some problems, as discussed later.

2.4 Wikis in organizations

Companies are increasingly looking into Enterprise 2.0 technologies in general and are planning to invest more in them in the future (McKinsey, 2009). According to various studies, wikis are quite popular in organizations. In a 2008 survey of wiki use in Finland, 59% of the 50 biggest companies in Finland was either using, testing or considering using wikis (Henriksson, et al., 2008). Another study in 2008 by AIIM revealed that 67% of companies are either using or planning to use a wiki (AIIM, 2008). According to Gartner, wikis are almost a mainstream technology, with an estimated 20-50% of companies using them (Gartner, 2009).

There seems to be no specific common factors among companies that use the wikis. Wikis are used in both small and large organizations as well as in various different types of companies (Hester, 2010).

Wikis used in organizations are usually located in the company intranet behind a firewall. Employees are also usually required to log in to the wiki with their own user name and the names of employees who make edits to documents are stored. Thus no outside parties can neither access nor contribute to the wiki. This approach is taken to prevent vandalism to the wiki. Gruding & Poole claim this approach also means that the organizational wikis can be difficult to use by employees from outside the office (Grudin, et al., 2010). However, the use of virtual private networking technology to enable staff to contact the company intranet from anywhere is already widespread (Venkateswaran, 2001), taking care of the access problem.

3. USING AND IMPLEMENTING WIKIS IN ORGANIZATIONS

In this chapter, more understanding of the use of wikis in organizational settings is sought, with emphasis being on this issues resulting from the unique properties of wikis, some of which were already discussed earlier. This is necessary to be able to assess the suitability of usability improvements later in the study, as the improvements should not diminish the unique properties of wikis as an Information System.

3.1 The wiki way of working

There is no strict definition for wiki way of working. It can be thought to consist of all the properties of a wiki that allow it to change the way work is being done in companies. Many of the properties are also related to key Enterprise 2.0 components, SLATES, which were introduced earlier. In this section, based on previous wiki research, those properties will be identified.

3.1.1 Everyone can contribute

As told earlier, the wiki allows everyone to edit any page in the system. This means that both the contents of the pages as well as how the pages are organized can be defined and edited by the wiki users (Cunningham, et al., 2001). Users are thus given more freedom than in traditional content management systems: In traditional content management systems the categorization of information is often predetermined (Gonzalez-Reinhart, 2005) and documents are not edited in the system itself. It is essential that a wiki should be easy for anyone to use, allowing everyone to participate. (Hasan, et al., 2006). This property is related to *authoring,* one of the key Enterprise 2.0 components.

Wagner describes information collection in a wiki is being almost anarchic. He claims that in the case of wikis, anarchy is a good thing. In organizational settings it enables teams to function efficiently by themselves without having to wait for permissions from management. (Wagner, 2004). Huang & Jing argued that the equality of wiki contributors is the most important aspect of wikis, and claimed that the wiki is a very democratic enterprise information system (Jing, et al., 2008).

Well known management consultant Peter Drucker also supported giving more power to the employees. He claimed that the productivity of knowledge worker has not improved for decades, and is relatively low. Drucker argued that managers should focus more on the strengths of the knowledge workers. As many knowledge workers know more about their specialty area than their managers, they should be treated as associates, or even as if they were working voluntarily for the organization. According to Drucker, their knowledge should be fostered instead of controlling them with traditional management methods. (Drucker, 1998).

As wikis enable the democratization of the work process, Hasan et al saw the wikis as one of the tools that can enable what Drucker suggested: By using a wiki, the information workers can store their knowledge together in a continuously evolving system that adapts to their needs. (Hasan, et al., 2006). Collecting information in a wiki also does not require storing it in a separate system as is often the case in traditional knowledge management systems. In a wiki, the knowledge management is a natural part of doing the work in the wiki and does not require any additional steps (Gonzalez-Reinhart, 2005).

3.1.2 Documents are worked on iteratively online

In a more practical sense, the wiki way of working allows organizations to reduce their internal transaction costs. For example software developers usually communicate through many formal and informal channels, including version-control repositories, email and instant messaging. The use of multiple channels to communicate may lead to inefficient communication among team members, because knowledge communicated through informal channels is easily lost. As a result of lost communications, there can, for example, be inconsistencies because of the same document being worked on by different people independently at the same time or obsolete documentation being used to guide work. These problems often lead to work being redone. (Fokaefs, et al., 2009).

Using e-mail as a document sharing tool to support collaboration in teams can lead to a large amount of messages being posted. Each time a member of a team makes a contribution to the

document being worked on, a new mail has to be sent to everyone. This has been shown to cause productivity losses (Whittaker, et al., 1998). If the work is being done in the wiki instead, the system automatically ensures that every collaborating employee is using the most current version of the document and everyone can see each other's contributions. This enables quick and easy editing of the document, including the contributions made by others, for example to add information or correct problems. (Jesdanun, 2004) (Cooney, 2006). By using a wiki the aforementioned coordination problems can be avoided, leading to smaller internal transaction costs at an organization. Kilpi claims that some organizations have managed to achieve 40% reduction in e-mail traffic by utilizing wikis (Kilpi, 2006).

While a wiki enables everyone to see the most recent version of a document, it also features version control that stores the previous versions of pages. The revision history of a document is thus always available for any user to see. (Yang, et al., 2008). Wikis also offer the possibility to compare what changes have been made between each version of the document and also by whom and when. (Cooney, 2006). If some unwanted edits are made, they can be reversed easily (Hasan, et al., 2006). This increases trust in the tool and also allows tracking of who has contributed what to the document.

The wiki's approach to content creation allows content to be created iteratively. It is possible for a group of people who are working on a wiki document to achieve collective meaning by contributing their own views and interacting with the information, also resulting in shared learning effort for the participants (Kilpi, 2006). According to Kilpi, any content in a wiki is a "perpetual beta" which means that a wiki is a "medium for continuous, creative learning" as everyone can participate whenever they wish by contributing more information.

3.1.3 Easy access to information

McAfee listed *signals* as part of the requirements of Enterprise 2.0 tools (McAfee, 2006). In a wiki, signals are offered by providing users RSS and ATOM feeds as well as e-mail alerts about what changes have been done to the wiki. A manager can for example follow the activity in the wiki without going through every page and only react when the manager sees some relevant

information in the feed. This also reduces amount of e-mail, or the use of other communication tools, as the manager can follow the status of the team by following activity in the wiki instead of having to ask each member of the team for status reports.

An essential part of the original wiki philosophy by Cunningham was that the wiki should be accessible from anywhere (Cunningham, et al., 2001). Whether employees are abroad, at an airport or in the office, they can still contribute to the wiki as well as anyone else.

Search is also one of the building blocks of Enterprise 2.0. There is also a built-in search function in the wiki to help users locate information in the wiki. (Radziwill, et al., 2004). Andersson et al even refer to the search as a "main advantage" of wikis. (Andersson, et al., 2007). The search function in the wiki can also be used to search for or include parts from other wiki pages to a wiki page. That means that only one wiki page needs to be maintained and there is no need to copy-paste information if it is necessary to show it or parts of it on another page. Thus wikis also have also easy access to information contained in other wiki pages.

3.1.4 Links between pages

Wiki pages are connected to each other by using links (Jing, et al., 2008). *Links* are also a key component of Enterprise 2.0. Wiki pages can be linked from multiple pages and it can also be shown which pages link to a certain page in a wiki. (Cunningham, et al., 2001). This approach to linking allows users to dynamically determine the relationships between information in the wiki (Hasan, et al., 2006).

As was already discovered, it is possible for users to alter all the content in a wiki. In addition to changing the content of pages in the wiki, it also means that pages can belong to certain categories in the wiki. This can be done with linking. Some pages in the wiki can for example simply be used as category pages containing links to all the pages belonging to that category. In order to change the category, the page link can simply be moved from one category to another. A page can also be listed on as many category pages as desired.

Even if a page's category is altered, the actual address used to access and link to the page will remain the same. This helps increase the easy access to the wiki and according to Cunningham also means that there are no broken links in wikis.

In some wikis it is also possible to use *tags*¸ another key Enterprise 2.0 component, to collaboratively structure the information. This can also be used to provide links as the tags from a folksonomy. It will be discussed later in more detail.

3.2 Wiki uses and best practices

Because of the freedom that a wiki offers to its users it can be claimed, as Louridas does, that there is no single correct way to utilize a wiki (Louridas, 2006). However, there appears to be some practices for which the use of wikis has a lot of benefits - or at least where a lot of wiki research is concentrated on. It is also important to find some of these practices so that benefits of wikis can be linked to work activities: It has been found in case studies that in companies which for example use both the SharePoint working spaces functionality and a wiki it is not always clear for the employees which system to use for collaboration in different activities (Munson, 2008).

There seem to be a lot of cases where use of wikis can be beneficial. A survey of 168 companies by Majchrzak et al revealed that the most common uses for wikis were in software development and project management, with lots of other uses as well. In the survey 80% of respondents stated that the wiki had made doing work easier. (Majchrzak, et al., 2006).

3.2.1 Project management

Project management is one of the areas where wikis can be beneficial and where they are also frequently used. (Holtzblatt, et al., 2010). All project information, such as coordination, requirements gathering, documentation or meeting minutes, can be done and stored in the wiki. (Dyer, et al., 2008). By storing the project information in the wiki, it is easily available for every stakeholder in a project (Hilska-Keinänen, 2009). In internal company projects, the customers of the project can for example directly follow the progress of a project from the project's wiki pages

(Al-Asmari, et al., 2007). This increases transparency within an organization. New stakeholders can also be easily included when needed. (Decker, et al., 2007).

Wikis were in fact originally created by Ward Cunningham to manage an extreme programming project. Extreme programming is a type of agile programming. In agile programming, the work is done in multiple short iterations, referred to as sprints, and the work that is done in a sprint is divided to items, which are again divided to tasks. In Cunningham's wiki, each item being done in the project had its own wiki page, as had every sprint. Programmers who finished an item could for example easily mark it as complete by themselves and an overview page was used to show the status of the entire project. When a sprint ended and some unfinished items needed to be moved from one sprint to a new sprint, it was enough to move the link to the item to the wiki page of the new sprint. This approach was found both easy and flexible, suiting the requirements of both the programmers and the stakeholders. (Cunningham, et al., 2001).

Wikis are currently used a lot for managing software projects because of their flexibility. For example a book for agile developers by Subramaniam and Hunt recommends using a wiki to inform all stakeholders about the progress of the project. (Subramaniam, et al., 2006). While there is a lot of research on wiki use on software projects, they are also suitable for other types of projects as well (Hilska-Keinänen, 2009).

3.2.2 Collaborative knowledge creation

Wikis are frequently used for storing and creating knowledge. (Holtzblatt, et al., 2010). The practical benefits of wikis are clearly visible when they are used to collaboratively work on documents. For example the newest version of a document is always visible to users. Everyone can edit it directly in the wiki, instead of having to send multiple e-mails. This especially benefits geographically distributed teams.

By empowering users to collaborate, changes can also be made quickly instead of waiting for editor approvals. (Wagner, 2004). The ability to collaborate also means that all documents that were previously written by only one person can easily be co-written (Hilska-Keinänen, 2009). A

practical use of this is for example for doing documentation about a software project, where those responsible for different parts of the project can easily write about their own part (Chao, 2007).

It is easy to edit documents spontaneously in a wiki. (Wei, et al., 2005). The ease of editing results in possibility for incremental knowledge creation and also means that people can volunteer by contributing to what they know about, for the common good. Ideally, qualified employees in an organization will take care that the information contributed by users is of good quality, as it can be assumed that organizations only hire capable employees (Hasan, et al., 2006).

Wikis are an asynchronous tool, meaning that anyone can participate in document creation only when it suits them. (Bean, et al., 2005). A wiki can thus be co-created and co-evolved (Hasan, et al., 2006). Because of this flexibility some claim that the use of wikis to create content results in emergence of collective intelligence. (Bairstow, 2003). A more practical benefit of this is enabling teams with members working in different time zones to contribute knowledge together.

The structure of the documentation in the wiki does not have to be predetermined, which means that documents can be self-organized by the users. This means that the wiki is an active collaboration tool. (Möller, et al., 2006) Wikis thus do not emphasize centralized control unlike traditional knowledge management systems, although that is also possible in some wikis (Hasan, et al., 2006).

Wiki can be used for knowledge management as a natural part of the way work is done. There is no need to use an additional tool for storing knowledge. (Gonzalez-Reinhart, 2005) An example of this is software engineers using a wiki for project management and at the same time storing all the problems descriptions and solutions on the wiki, resulting in a large knowledge base. For example Radziwill and Shelton report on a case of successful wiki use in a software company, where programmers used a wiki to frequently document software projects and collaborate on solving problems, with all the information available for anyone in the wiki on the company intranet. (Radziwill, et al., 2004). Hester especially recommends using wikis for organic knowledge bases, where information is evolving over time and thus benefits from the nature of wikis (Hester, 2010).

It is also possible for a company to open up and use the wikis to create content together with customers. While this might require close monitoring because of the threat of vandalism, Wagner & Majchrazk nevertheless argue it makes it possible for much closer interaction with companies and customers (Wagner, et al., 2007). Some companies, such as SAP, are currently using a wiki together with customers. (SAP, 2010).

It is true that many intranet systems, such as SharePoint, can also be used to store knowledge. However, in SharePoint, the information is mostly stored as attached documents. Munson found that due to the multiple steps involved in working with attachments, users feel this approach constraints them, not allowing for spontaneous knowledge gathering. Information in such systems may also be more difficult to locate as documents cannot be easily linked to one another and information is located in different folders. (Munson, 2008).

3.2.3 Team communication

Teams frequently use wikis to communicate. These communication activities include for example sharing what the team is working on to everyone on the team's own wiki page. (Farrell, et al., 2008). Ad-hoc conversations can also be easily stored in the wiki, due to the wikis' flexible nature. (Phuwanartnurak, 2009). In addition to "formal" teams, also ad-hoc groups and larger communities have been shown to utilize wikis of their own. (Farrell, et al., 2008)

If a team is using a wiki for example for project management, the virtual team communications also have a new level. It is easy for the members of the team to for example see what each member of the team us working on. If the wiki is also being used for knowledge management, the team members can also see what problems others are having or share their own. Lanubile refers to this kind of activity as something previously shared as "corridor talk" that leads to "peripheral awareness" (Lanubile, 2009). Wikis thus can allow this type of communication to occur also in virtual projects with members in different time zones and/or geographical locations. It is notable that this also occurs as part of the normal work activities, not requiring the use of an additional tool.

3.2.4 Community building

The possibility of everyone to use a wiki to participate in for example the activities mentioned earlier can also lead to building of communities. As employees across the organization participate in creation of knowledge, it also makes it possible to building communities among employees. (Hilska-Keinänen, 2009). Andersson et al found that some users also recognized this aspect of the wikis on their own and found it important (Andersson, et al., 2007).

Wikipedia, the volunteer effort to build an encyclopedia using a wiki, has attracted a large community of users. It demonstrates how the openness of the wiki approach can attract a dedicated community even willing to do work for free by getting enjoyment from being able to openly share what they know to others (Lih, 2009).

3.3 Implementation issues

To be able to better understand issues which may be affecting wiki use, especially in the case study done later, research on issues that can arise during the implementation of a wiki are also reviewed.

3.3.1 Wiki freedom can be seen as a threat

The nature in which wiki pages are created – everyone is able to edit anything – can cause concerns in an organization. While the content in most traditional content management systems remains stable, the contents of the wiki can always be evolving and changing. This openness also makes it possible to vandalize the content (Wagner, 2004). According to Dickerson, this can be seen as a threat by managers (Dickerson, 2004). It is possible to address these concerns by restricting access to wikis so that only some can edit different pages in the wiki but it is not recommended as it has been found to lead to a decrease in contributions made to a wiki (Stocker, et al., 2009).

As was already told earlier, Wikis record all the edits made and store every revision of a page. In case of unwanted edits, the older version of a page can also be restored. In most enterprise wiki systems, the name of the user who made modifications to the wiki is visible to everyone. (Wei, et al., 2005). Hasan & Pfaff claim this is enough to ensure that users take no malicious actions as that would not be good thing to do from a career development perspective. They also suggest that the broadening of the responsibility of information gathering as well as categorization is very beneficial and should thus not be seen as a threat but as an opportunity by managers (Hasan, et al., 2006). Findings by White & Lutters support this view, as their study on wiki use found that employees are not afraid that others will destroy their content (White, et al., 2007).

3.3.2 Managerial support

As is the case in the implementation of most information systems, managerial support is needed to enable the success of a wiki within an organization (Stocker, et al., 2009) (Kenney, 2008) (Hilska-Keinänen, 2009). Also supporting management's key role, White & Lutters found lack of management support a key reason in case study of a failed wiki adoption (White, et al., 2007). Managerial support is specifically needed so that management can pay attention to enabling the culture of a wiki way of working, as there can be a need to support changing of the existing corporate culture.

Grudin and Poole claim that gathering managerial and executive support for wikis is actually easy. However, they also claim that in the case of wikis, it seems that securing initial manager support may not be enough to enable their commitment to continued use of the tool. This is because managers and the users may have different views and expectations on how the wikis should be used, leading to conflicts. According to Grudin & Poole, while the ability to gather and organize information so that it can be found and monitored easily is what appeals to managers about wikis, employees on the other hand tend to use it more for communication in a quick and informal manner. Thus there is a need to avoid setting unrealistic expectations for executives so that middle managers do not have to mediate between two conflicting views on how to use wikis. Grudin & Poole claim that these kinds of conflicts of interest are similar to findings from all

other collaborative tools but they still seem to surprise researchers every time they are found. (Grudin, et al., 2010)

3.3.3 Unofficial wikis

There is also a way to start using wikis in an organization without having any initial management support – or even without managers knowing about the implementation. For example in the survey by Henriksson et al numerous companies were some group in the organization had started to use the wiki on their own were discovered. As employees began to find the wikis useful in their daily work, the word about it spread and even more users started to use it. At some point the wikis usually became an official IT tool. (Henriksson, et al., 2008) .

The findings of unofficial wikis indicate that there are employees who perceive that a wiki helps them so much in doing their work that they are willing to spend their own time to take it into use in companies. In a case study of agile programming practices at a large multinational corporation Moore et al found that programmers were even willing to use a wiki covertly because of the benefits it offered in collaboration. The use of a wiki continued even though the internal IT department required the use of another tool and had forbidden the use of other tools (Moore, et al., 2007).

Covert and employee projects are common for Enterprise 2.0 solutions. They can also cause unique challenges for IT management in companies. Employee initiated projects can also lead to failures if for example just one department in a company starts using a tool, leading to the creation of a silo, as Hinchcliffe points out. (Hinchcliffe, 2009).

3.3.4 Wiki champions and shapers

Wiki use in organizations benefits from employees who enjoy working on the wiki to improve its structure and maintaining the information stored. These employees may also be willing to help others in using wikis. (Cunningham, et al., 2001) Many roles for these beneficial wiki enthusiasts have been identified in later research.

One identified role is a champion. According to research in online communities by Cheung et al, a champion is someone who makes sure that the wiki is developing and encourages people to contribute. The champion may be the same person who founded the wiki, but does not have to be. Cheung et al recommend that champions should also be developed to ensure continuous development of the wiki user community (Cheung, et al., 2005). Both Kenney and Hester suggested that it may also be beneficial to appoint a champion in corporate settings. Hester also suggest trying to find existing champions for example by doing surveys. (Kenney, 2008), (Hester, 2010)

Two additional wiki contributor roles have been identified. Majchrzak et al found that these are shapers and personal knowledge contributors. Personal knowledge contributors are employees who are willing to share about areas that they know best in the wiki. Shapers, on the other hand, are those who seek to improve the overall wiki experience for the benefit of the entire user community by reorganizing content to make it more usable for everyone as well as by doing other administrative tasks, but have only little personal knowledge to share. Both roles were identified and found important in an analysis of a successful community. (Majchrzak, et al., 2006). Wu et al nominated specific people to work as shapers in case studies of a wiki system and found that the existence of shapers is beneficial in improving results. (Wu., 2010). Edwards refers to similar practice as “wiki gardening” and recommends that such a role should be rotated amongst the wiki community members in corporations (Edwards, 2007).

3.3.5 Need for training

Although it is possible to start using a wiki in an organization without any formal involvement (Hasan, et al., 2006), Wei et al suggested that there is a need for formal training to get employees accustomed to how the wikis work. They especially pointed out the need for users to learn about features that are unique wikis, such as functionality used for categorization. (Wei, et al., 2005). Numerous case studies have also found that employees themselves wanted to have some training for wikis, as they felt wikis were complicated to use, especially in creating content. (Da Lio, et al., 2005), (Henriksson, et al., 2008), (Andersson, et al., 2007). Additionally, Edwards pointed out that new employees hired in a company that uses a wiki will also need to be educated

(Edwards, 2007). In case studies where training was provided to users, it was found to be popular among the employees and was also identified as success factor in wiki use. In addition to training, peer support from other, more experienced users, has also been found important. (Hilska-Keinänen, 2009) (Ben-Chaim, et al., 2009).

3.3.6 Wiki anxiety and reluctance to modify content

Cowan et al proposed that the ability to edit all the content in a wiki can cause anxiety for some users. The evolving nature of wiki pages increases uncertainty, as the pages can look very different every time users visit them. It was found that users who felt anxious contributed significantly less to the wiki than those who did not feel anxious. It was also found that anxiety correlated negatively with wiki usability. The respondents' views about usability and their anxiety levels did not change over time, so having more experience did not help to alleviate anxiety. (Cowan, et al., 2008)

Reflecting on the study in a later article, Cowan et al speculated that users might become anxious for wikis if they have had a bad first experience with wikis. After a bad first experience, gaining more experience with the system will not help users to change their view. The jargon associated with wikis also contributes to viewing them negatively. Cowan et al suggest that the worse the usability of a wiki is, the more chance there is of a bad first experience, leading to lost faith in being able to use the system. As no studies have been done on if improving wiki usability helps avoid a bad first experience, it is unclear if that might also reduce the probability of anxiety. Also no studies about what effect improving the usability of wikis later has on anxious users have been done. (Cowan, et al., 2009)

Some researchers have also found that employees may be reluctant to modify content made by others in organizations. (Kenney, 2008) (Danis, et al., 2008) (Yochai, et al., 2009). Munson found this was because of employees felt that the content belongs to the original author. (Munson, 2008). There have also been related findings that some employees only want to publish "finished" content, and that this occurs especially in the early phases when the wiki is introduced. Holtzblatt et al claim this is because employees feel they would lose control of the information by

making it possible for other people to finish the work before they have had the chance to do it (Holtzblatt, et al., 2010). Phuwanartnurak saw this fear being related to employees lacking experience of wiki use. (Phuwanartnurak, 2009). In a case observed by Da Lio et al, employees did eventually start posting also unfinished content and to work collaboratively, but it took some time. (Da Lio, et al., 2005)

These findings mean that those seeking to increase wiki use might encounter people who will have deeply negative feelings for the system due to previous bad experiences or those who simply do not like to work collaboratively.

4. THE USABILITY OF WIKIS

Wikis pose unique challenges to keep the entire wiki usable for all the users of a wiki. This chapter includes some general findings about IS usability, but mostly focuses on specific wiki-related issues identified in research, including means to resolve the issues.

4.1 General reasons for usability improvements in information systems

According to the ISO 9241-11 standard usability refers to the extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use. (ISO 9241-11, 1998). In information systems, the focus is on the user interface, the elements that users use to interact with the system. It can be assessed how well designed the various functionalities are. Issues to focus on include menu design, consistency and easy means of navigation. Usability engineering can be used to improve the user experience by making the functions easier for the users to use (Donahue, et al., 1999).

There are many general reasons why it is beneficial to improve the usability of an information system. Donahue et al list general benefits of improving usability. The main benefit found is better productivity. This is a result of the users making fewer errors and needing to take less training before being able to use a program. Users will also no longer feel frustrated because of systems that are hard to use, which results in increased satisfaction at work. There is also less need for user support. The usability improvements thus lead to better productivity. It has in fact been estimated that a dollar invested in usability improvements results in benefits of 10 to 100 dollars. However, if the usability is taken into account already when an information system is designed, there costs are even smaller as for example the interface design needs to be done in any case. (Donahue, et al., 1999)

4.2 Definition of wiki usability

Due to multiple different requirements, the usability of wiki not only concerns the basic user interface used to view data but also the effectiveness of the methods that users can use to govern and create content in the wiki so that the wiki remains usable for all the participants. This means

that the needs of both the information producers, information reorganizers and the information seekers need to be met. As the usability requirements for these three roles differ but must all still be satisfied at the same time it means that there are special challenges regarding the usability of wikis. (Wei, et al., 2005).

4.3 Wiki usability findings

To be better able to find ways to improve usability, specific problems need to be identified first. As told earlier, wikis are special form of information technology in terms of usability because they have to cater for the requirements of the different roles of the users who need use the system. To reflect these different needs, this chapter is divided into three sections; content creation and editing, organizing content, and information discovery. Generic user interface difficulties will also be discussed.

4.3.1 Content creation and editing

As giving every user the possibility to edit content in the wiki is arguably the basis of what makes them special, editing the content should be easy for everyone. Hasan & Pfay, for example, argue that it is essential that even users with just basic computer skills are able to contribute to the wiki in all possible ways, not just by modifying information on existing pages but also by adding new ones (Hasan, et al., 2006). There are two ways to add or edit content to wiki, either by using wiki markup or by using graphical WYSIWYG editors.

In many wikis, users have to learn a markup language referred to as wiki markup, a specific code language, to format the information in the wiki. When wiki markup is used, users are not able to see the results of the formatting until they save the edits they have made and view the page. Although there are ongoing efforts to standardize the wiki markup, the markup is different for each wiki. The basic method to format text is still similar, with formatting commands placed around the text that is to be formatted. (Sauer, et al., 2007).

According to Wagner it is effortless to add content to the wiki despite having to use wiki markup (Wagner, 2004). Yang et al also agree that it is easy to create content in the wiki (Yang, et al.,

2008), as does Hilska-Keinänen (Hilska-Keinänen, 2009). There are also many who specifically argue that wiki markup is easy to learn. Chau & Maurer claim that especially software engineers are able to learn the markup quickly. The findings of their case study also supported that claim, although they admitted that results might have been different if the users had not been programmers. Buffa found that some users who did not contribute to a wiki said this was because the wiki did not have a WYSIWYG editor. (Buffa, 2006). He claimed that this was only an excuse for not using a wiki and not a real reason, which according to Buffa was likely unwillingness to change habits.

On the other hand, many claim that it is difficult to learn at least parts of the wiki syntax. While Wei et al agree that basic text editing is quite simple they also claim that any additional formatting such as adding tables is difficult for the end user (Wei, et al., 2005). Empirical findings seem to support the view that there are many users who do in fact find the wiki syntax difficult. Da Lio et al found that even users who had a technical background found the wiki syntax difficult to learn due to its complexity (Da Lio, et al., 2005). Kickmeir-Rust et al found that because of the wiki markup the wikis do require specific computer skills and wikis can thus be difficult to use in their case study of wiki usability (Kickmeier-Rust, et al., 2006). Munson also found that having to learn wiki markup is a barrier to wiki contribution and there are many users who find the markup difficult (Munson, 2008).

As told earlier, Chau & Maurer found that software programmers did not have difficulties with wiki markup. Later studies comparing different users of wikis have uncovered more evidence to support this claim while also supporting their predictions of non-technical people having trouble. White& Lutters found that technically oriented employees did not have trouble with wiki markup while non-technical employees did (White, et al., 2007) and Stocker & Tochtermann found that employees with technical background were actually willing to learn the syntax, whereas others were not (Stocker, et al., 2009). At IBM, many of the enthusiastic corporate wiki users were very proficient with the wiki mark up and, describing themselves as professional wiki users, felt that the wiki was easy to use (Arazy, et al., 2009). Interestingly, Ben-Chaim et al found in their case study that even software engineers experienced problems with wiki markup, such as difficulties with formatting text (Ben-Chaim, et al., 2009), contradicting the earlier findings.

The Wikimedia foundation, the organization behind Wikipedia, has also conducted studies on wiki markup as part of their ongoing study focusing on improving the usability of Wikipedia. They found that while most users are able to make changes in existing texts, the markup's complexity reduces the users' ability to do anything more. Desilets et al recommended using wizards to ease the process of writing wiki markup, in case a WYSIWYG editor cannot be installed (Desilets, et al., 2005). Such functionality is available in Wikipedia in the form of a toolbar that adds wiki commands when an icon is clicked. It was found in Wikipedia's own usability study that only when the users actually recognized what an icon in the toolbar meant was it found useful, which was not always the case, and thus pointed out that it was important to pay attention to icon design in toolbars (Wikimedia Usability Initiative Team, 2010). The icons were later made easier to recognize and more users then found the toolbar helpful. However, even when the toolbar was improved, troubles with wiki markup still restricted many users. (Wikimedia Usability Initiative, 2010).

Despite numerous negative findings about wiki markup, Dy Di Wu, while reporting on a group that tested a new version of a software engineering system based on a wiki, was still surprised to learn that users found the wiki markup difficult to learn and use in a very recent study (Wu., 2010). Thus it seems that there is still no overall agreement about whether the wiki markup is difficult to learn or not.

To sum up, based on existing research it can be concluded that there are users who can learn the wiki markup quickly and can use it efficiently. But there are also many who do not want to learn it nor can efficiently utilize it, thus leading to those users being unable and/or unwilling to contribute to the wiki. Thus it can be argued that if only wiki markup is used for editing and creating content, a wiki is not easy for everyone to use and thus fails in the basic tasks it sets out to fulfill, even though wizards can help to assist users.

General usability theorists suggest that whenever users have to learn code to create content, it requires a lot of effort, at least for some. They insist that offering a graphical editor, referred to as WYSIWYG (What You See Is What You Get) editor is beneficial. (Nielsen, 2001) (Sinkkonen,

et al., 2006). However, Ward Cunningham, the creator of the original wiki felt differently. He insisted that it actually takes more time to edit text using a WYSIWYG editor, because of the additional effort required by formatting. Cunningham also argued that it is better to use raw text as much as possible because, according to him, it allows users to focus only on the content. In corporate context, this is however not possible. Content that is presented in corporations needs to be able to look polished and professional. Gruding & Poole found that the lack of formatting options can cause problem even in the corporate use of modern wikis (Grudin, et al., 2010).

Based on their case study using a wiki that only used wiki markup, Desilets et al suggested that a WYSIWYG editor would be the perfect solution for most of the wiki's usability concerns. (Desilets, et al., 2005). Honegger also found that the lack of a WYSIWYG editor was a significant barrier limiting the use of wikis. (Honegger, 2005). Chau & Maurer on the other hand claim that a WYSIWYG editor is not a good option as users would have to learn to use another tool than just the wiki (Chau, et al., 2005). Their study is quite old, and this claim has been invalidated as current web technology allows WYSIWYG wiki editors, such as TinyMCE (Thoeny, 2010), to function within the wiki.

Some might claim that as Wikipedia, the most prominent wiki, does not offer a WYSIWYG editor and still manages to be successful, it is not a requirement for easy editing of data. However, even Wikipedia's own studies have found that a WYSIWYG editor would be the only way to ensure that everyone can use a wiki to create and edit content. Their report states that the reason for not installing a WYSIWYG editor in their case is that it is currently not desirable to make editing Wikipedia easy for everyone due to other "legitimate arguments". (Wikimedia Usability Initiative, 2010)

When a good WYSIWYG editor is used, users seem to regard the wiki as user friendly. Andersson et al monitored users of the Confluence enterprise wiki at a case company. Confluence includes both a WYSIWYG and a raw text editor. It was found that users reported the WYSIWYG editor as being very user friendly and praised the ease of content editing in the wiki. In that case company, wiki's ease of use was mentioned often in feedback. Users also liked that the interface of that wiki was similar to already used tools. It was also found that the raw text

editor was very rarely used. (Andersson, et al., 2007). Chao also used a wiki with WYSIWYG editing in a case study. Users found that wiki to be easy to use. Most users stated that the well working WYSIWYG editor was an essential factor in enabling them to contribute to the wiki. (Chao, 2007)

It unfortunately seems that WYSIWYG editors that are provided with wikis are not always user friendly. White & Lutters found that all users experienced trouble as the WYSIWYG editor used in the wiki they monitored lacked functionality (White, et al., 2007). Stocker & Tochtermann also found that ordinary users regarded the editor used in the wiki they were following as being uncomfortable, although "not as bad as" having to learn wiki markup. (Stocker, et al., 2009). Henriksson and Mikkonen however found that it was very rare for users to complain about difficulties with WYSWIG editors in their study of wiki use (Henriksson, et al., 2008). Unfortunately the names of the wikis investigated were not mentioned in the studies. It can still be concluded that the mere existence of a WYSWYIG editor is not always enough to ensure that content creation is easy as also the WYSIWYG editor can in some cases be difficult to use.

4.3.2 Hyperlinks

Hyperlinks are one of the original cornerstones of wiki technology. They are used to link content in the wiki with other content so that information is placed in context (Wagner, 2004). They can also be used for categorizing information in the wiki and to create new pages. According to Leuf and Cunningham, it is easy to create hyperlinks in a wiki (Cunningham, et al., 2001).

Other researchers also claim that link creation is both fast and easy in a wiki (Cunningham, et al., 2001), (Fuchs-Kittowski, et al., 2005), (Decker, et al., 2007), (Wagner, 2004). Wagner and Cunningham claim that he use of Camel Case makes linking easy. As explained earlier, this method involves writing words together, with each word starting with a capital letter, to create links. However, according to Lih, the users of Wikipedia who were not used to programming did not like the Camel Case. To resolve this, a new method to create links, putting page names in double brackets, was developed and is also used in Wikipedia and many other wikis today. This can however be considered to be only a minor change as linking still requires users to learn some

wiki syntax. However, Bairstow and Decker et al, for example, describe that this syntax to create wiki links is also easy (Bairstow, 2003) (Decker, et al., 2005).

Despite many others claiming that hyperlinks are easy to make in a wiki, Wei et al claim that creation of hyperlinks is actually difficult in a wiki (Wei, et al., 2005). In one of the few studies focusing on wiki usability, Desilets et al found empirical evidence that this seems to be the case. Even though they tested wiki use on school children, it can still be seen as alarming that over 50% of users had encountered problems with link creation and hypertext management. Because of these problems Desilets et al claim that wiki syntax is not efficient for creating links between documents. (Desilets, et al., 2005). Wikimedia's usability and experience study also found that many users did not recognize that links should be used to create new pages and users also thought that link creation was difficult (Wikimedia Usability Initiative Team, 2010). Thus it can be concluded that link creation in wikis is not easy for everyone, and they are also not an obvious way to create new pages.

4.3.3 Advanced ways to organize content

There are also advanced ways to organize wiki content, such as using parent/children relationships for organization instead of simply using links. This enables for example the generation of page maps without the need manually create links. However, Wei et al claim this functionality is difficult and unintuitive to use. Users would also have to know that such functionality even exists in order to attempt to find it (Wei, et al., 2005). Supporting this claim, Kickmeir-Rust et al found that most users are not really using the functionality (Kickmeier-Rust, et al., 2006). The proliferation found in wikis (Happel, et al., 2008) which is discussed in the next chapter also supports the view that organization of information in wikis can be difficult even though there are multiple ways available.

It is possible to also use tags to categorize information in wikis. There are however no studies mentioning who easy the tagging functionality is to use in different wikis.

4.3.4 Information discoverability

Many researchers claim that it is easy to navigate in a wiki and to find information (Cooney, 2006) (Benjamin, et al., 2009). Fuchs-Kittowski and Kohler even refer to the ease of navigation as a "winning feature" of wikis (Fuchs-Kittowski, et al., 2005). Van Deursen for example claims that the back links, an automatic search function that shows which pages link to a current page, ensure easy navigation (VanDeursen, et al., 2002). There is also empirical evidence to support these claims. Da Lio et al. for example found wiki navigation to be easy in their study of wiki use in an academic community (Da Lio, et al., 2005).

Leuf & Cunningham claimed that there is no need for wikis to have someone updating maps or creating indexes to aid navigation. However, even they already suggested that finding information in the wiki can become more difficult as the amount of content grows. These problems are referred to as proliferation. Happel & Treitz describe proliferation as the measurable problems related to the growth of the amount of information added to the wiki (Happel, et al., 2008). These include not being able to locate content easily, decrease in the quality of information in the wiki and problems with the structure of the entire wiki. Chau & Mauer found evidence of the phenomenon already in their early case study of wiki use (Chau, et al., 2005). Thus it seems that while the navigational methods in a wiki are easy to use, they are not enough to provide efficient methods to discover information in the wiki as it grows. This also suggests that using only linking is not enough to categorize content.

4.3.5 Differences between wiki platforms

It has been found that the usability of open source software can be problematic (Nichols, et al., 2003). As many wiki platforms open source, they may for example suffer from a badly designed interface. Some may for example not like the back-to-basics approach taken by the original wikis. Wei et al describe the look of most wikis as "primitive" by default, reminding of early web pages. They claim that the simplistic look might even discourage users from contributing to the wiki. (Wei, et al., 2005).

Some researchers have compared the usability of different wiki platforms. Liang et al compared the two popular open source wiki platforms, TWiki and Mediawiki in a comparison study of two student groups that used different wiki platform. It was found that Mediawiki was perceived as being easier to use than TWiki and because of this it was also perceived as a more suitable tool for collaboration. There were still problems found in the interfaces of both of the platforms. (Liang, et al., 2009). It is notable that while the wiki markup used in both wiki platforms is similar, the differences in the user interface alone were enough for the users to perceive the other system as being more user-friendly. This confirms that also the user interface of a wiki seems to play a key role in wiki usability.

It is somewhat problematic to compare various wiki platforms. On most wikis, it is possible to customize all elements of the interface. For example, the TWiki platform offers various different "skins" that change the look and feel of the wiki and also the positioning of the interface elements (Thoeny, 2009). Those with programming knowledge can customize them further as every part of the interface seen by the users can be tailored. (Thoeny, 2010). It can be assumed that the studies comparing platforms only compare the default look the wiki systems. As the interface can be customized, it may also mean that those who are not familiar with usability issues may have created the look and feel of the wiki. This means that similarly to web pages, even some basic user interface issues, such as placing the most frequently used functionality so that it can be accessed easily (Nielsen, 2001) may have not been paid attention to.

It is perhaps because of general user interface difficulties in wikis that Gholami and Safavi found in a study of wiki user preferences that there was a desire for users to also be able to personalize the wiki interface. Another desire was the need for easy navigation (Gholami, et al., 2010). They however did not specify what wiki platforms were being used for the study.

4.4 Methods to resolve problems with wiki usability

4.4.1 Improving wiki editors

As some WYSIWYG editors have been found to be problematic, attention needs to be paid to the capabilities of the WYSIWYG editor in a wiki to make editing a pleasant experience for

everyone. On the other hand, usability experts also recommend that making information systems easy to use for novice users is not enough. Information systems should also offer an option for power users to use more efficient means to contribute (Sinkkonen, et al., 2006) (Nielsen, 1994). In the cases of wikis it can thus be recommended that the wiki should provide both an easy to use and advanced WYSIWYG editor as well as a wiki markup editor for power users to satisfy the usability requirements of those users. There is also empirical evidence to support this claim. In for example Chao's study where a well functioning WYSIWYG editor was offered in a wiki, some users still preferred to use the raw text editor. The raw text editor can also be made easier to use by offering well designed wizards (Desilets, et al., 2005). The wizards were found to be useful in Wikimedia's usability studies (Wikimedia Usability Initiative, 2010).

4.4.2 Making link and page creation easier

While many do find link creation in a wiki simple and effective, it is not easy for all users. Alternative means to create links should be devised. Desilets et al suggested creating wizards to aid link and page creation. (Desilets, et al., 2005). This can be done with small applications, described later.

It is also possible to include automated searches in more advanced wikis to prevent the need to create links altogether. (Thoeny, 2010). This might however increase server capacity requirements as such automated searches can be resource intensive.

4.4.3 Manual reorganization of information

Leuf and Cunningham suggested that to prevent proliferation of content in wikis, some users should focus on making the information in a wiki easier for everyone to access. (Cunningham, et al., 2001) The wiki shapers and champions that were introduced earlier may be eager to do these tasks. They can use manual labor to clean up the wiki, rewrite information and reorganize the content. (Majchrzak, et al., 2006).

Manual reorganization may work for smaller wikis but as Happel & Treitz notes, this approach is inefficient in larger wikis, where it becomes time consuming for just a few enthusiasts to try to

reorganize all the content in the wiki. A more effective method is creating sub categories for information posted to the wiki. Some wikis enable this by allowing the creation of “parent” and “child” pages: A page that is created from a link added to a parent page will automatically become its “child page”. This relationship is shown in a breadcrumb visible in the wiki interface, but does not affect the link to the page, thus keeping up with wiki principles. Automated searches can also be made to show the child pages of a wiki page. A more extreme measure is limiting the rights of employees to edit content in the wiki (Happel, et al., 2008). It however conflicts with the wiki way of working and has also been shown to reduce contributions (Stocker, et al., 2009).

4.4.4 Using tags to organize content

Tags are simple free text labels, single words or short phrases that can be attached to documents to describe their content. They are a part of the Enterprise 2.0 criteria introduced by McAfee (McAfee, 2006). A feature that simply makes it possible for users to annotate the data they are creating is nothing new, but what makes tagging different is a folksonomy (Russell, 2006).

The folksonomy is all of the tags that users of a shared content management system have applied to individual pieces of content in order to group or classify those pieces for retrieval (Sturtz, 2004). Typically, the aggregation of tags, the folksonomy, can be shown as a tag cloud, a visual presentation of all the used tags. The attributes of the text in the cloud such as size, weight or color are used to represent features. (Halvey, et al., 2007). Usually, the features include relative popularity based on the frequency they are used to describe content. By clicking on any of the tags, the data matching it can be retrieved. It constitutes one of the main means of navigation in the dataset (Kakali, et al., 2010).

Russell claims that by allowing users to see everyone’s tags in aggregate form and to pivot between viewing the information being tagged makes organization of information with tags easier and more effective than using other methods. (Russell, 2006). Because more tags can be added or tags can be removed whenever needed, the folksonomy is constantly evolving. The folksonomy aggregates collective intelligence. (Mican, et al., 2010)

Tag reuse means that instead of constantly adding new similar vocabulary to describe content, which would be bad for categorization and information quality, old similar tags are used to describe the information. Tag reuse can be used to measure the quality of the categorization. (Hayman, 2007). Millen & Feinberg found in a study of folksonomies that tags were constantly being reused by the users, confirming good quality. While users constantly entered new bookmarks, new tags were not appearing as frequently, indicating that tag reuse also grows over time. (Millen, et al., 2006).

However, some problems have been identified as well. Those include misspellings, using tags only as shortcuts, tag ambiguity and using professional vocabulary not understood by others. (Gaofeng, et al., 2008). Same words can also have multiple meanings, but analytical methods have been developed to cope with this (Au Yeung, et al., 2007). A more critical problem is that of actually persuading users to apply the tags. According to study by Ames et al, the tagging functionality should at least be easily accessed and easy to use. (Ames, et al., 2007)

It is possible to use tags to categorize content on many wiki platforms. Andersson et al found it essentially important for a wiki to have tagging to complement the search engine and to prevent proliferation in their case study (Andersson, et al., 2007) . Decker et al presented a concrete need for tagging by including them as a way to mark the version of software being designed with version tagging, so that it would be possible to quickly find the documents that need to be changed when a new version of software is introduced. Looking from the wiki way of working perspective, there is no reason why tags should not be used. Tags can be created, added and deleted by all the users and they result in emergence of collective intelligence in the folksonomy. This is very similar to the wiki philosophy.

4.4.5 Semantic wikis

Semantic wikis are a new development of wikis where tags are used in creating content. The basic idea is that instead of adding separate tags to describe pages, the users annotate the content with tags that are placed within the content itself to make it machine readable (Krötzsch, et al., 2006). The potential of this approach can be illustrated by an example. In a document containing

project information, the document itself could be categorized as a project, as is also possible with current wikis. But in addition, all the descriptions of requirements for the project can be annotated as such, and all the mentions of people that are working on a requirement can also be annotated as being names of people. The wiki could then be used to search for example the names people that have worked on with specific requirements with a single search algorithm instead of going through the wiki manually. Thus a semantic wiki for example provides methods to ensure consistency and increase automation (Decker, et al., 2005).

While the potential of semantic wikis is huge they unfortunately introduce many additional usability issues, such as the need to create an ontology, the vocabulary used to categorize the content (Schaffert, et al., 2005) and making annotation easy for end users (Schaffert, et al., 2008). As semantic wikis can be thought of as a separate system, they are out of scope of this research, but because they share many properties of traditional wikis (Quan, et al., 2008), they too can potentially benefit from this research.

4.4.6 Wiki templates

In some cases it makes sense to structure repetitive actions that occur in a wiki. Kenney even lists structuring as one of the key strategies for implementing successful wikis. (Kenney, 2008). Templates can be used to enable the reuse of content in a wiki (Di Iorio, et al., 2007).

Leuf and Cunningham suggested that there should also be individuals who seed wikis with premade content and who add structure as it is needed to make content creation easier. They also warned that imposing structure can only be successful if it is seen as beneficial by the wiki community. While it might seem contradictory to impose structure to wikis it can be done in a way that does not limit users' freedom to modify everything by utilizing templates. There are two basic ways to use templates, differing on the degree of enforcing structure.

The first type of template is a functional template. The functional template is stored separately in the wiki. Wiki commands or a graphical editor are used to feed data into the template and show it on the page. This approach ensures consistency of the pages that use the template: all

modifications to the original template will be shown on all pages. However, this approach also means that users cannot easily modify what type of data to include on the wiki page, conflicting with the wiki way of working. As Di Iorio et al note, this approach might still be useful for storing data records that need to be made consistent. (Di Iorio, et al., 2007).

Wikipedia uses functional templates in various ways, for example in the category specific info boxes on that benefit from being consistent. While the templates were at first defined by administrators, they can now be maintained by the entire Wikipedia community. (Stvilia, et al., 2007). Möller & Birn recommends using functional templates for software documentation because of the ability to make changes that appear on all pages (Möller, et al., 2006).

Another type of template is a creational template. Similarly to functional templates, the templates are stored in a separate place in the wiki. As a new wiki page is started, users can to choose to base its original content on the template. However, after the page has been created, the users can freely modify the entire page, even by removing all the elements of the template if they so desire. (Di Iorio, et al., 2007) This approach is consistent with the wiki way of working. However, the ability to make changes to all pages that use the template is lost. If the template is modified, the changes will only be visible on new pages created based on that template.

The original wiki made by Ward Cunningham already supported creational templates. In Cunningham's wiki, the templates were used to assist with repetitive tasks, such as adding a new item to an agile programming sprint. They were also used to seed pages with premade content. (Cunningham, et al., 2001).

Some advanced wikis, such as Twiki and Mediawiki offer users the possibility to combine creational templates and functional templates In TWiki, creational templates are simply referred to as templates, whereas functional templates are referred to as forms. A TWiki form is a table that defines form fields to use for storing structured knowledge. A form can be attached to a wiki page and its contents can be edited alongside the normal editing process. The form functions similarly to functional templates, meaning that changes made to the wiki page defining the form fields also alter all the field descriptions that are shown on pages that use the form. (Pastorelli,

2009) For example, if the field “priority” is removed from the form page, the field and all the data inputted by the users to describe the priority of the wiki page will be lost, although the data can still be seen from page revision history. Meanwhile, if a new field is added, it will show up on every page, but will remain empty until users input the data. Thus, while the wiki way of working can be followed with the forms, it may make sense to limit the users’ ability to alter the forms to prevent accidental damage to the pages.

In TWiki, the forms can be included with the creational templates (Thoeny, 2010). Thus, users who design templates can themselves decide what data to store in structured form in functional templates and what data to store as creational templates, depending on the need to modify data.

4.4.7 Using small applications to assist users and structure repetitive actions

Some wikis such as Twiki and Mediawiki make it possible to develop small applications to be used in the wiki using advanced wiki markup (Anslow, et al., 2007). Many of these applications are already included in wiki platforms by default. They can for example be used to improve wiki usability, such as by making creation of new pages easier or by assisting moving of pages to different categories in the wiki (Thoeny, 2010). The applications can also be included in readymade templates so that users do not have to learn the wiki markup to use the applications. (Daum, 2008).

The applications make it possible for many different kinds of advanced functionalities to be used in wiki pages. Dickerson for example describes being able to generate checklists on the wiki using a simple interface created for TWiki. (Dickerson, 2004). Buffa reports on a company using TWiki applications that for example include easy editing of tables and spreadsheet calculations in the wiki itself, as well as seeing tables generated by the wiki itself to help access information. (Buffa, 2006).

There is a lot of research where TWiki applications are created by researchers to address a specific situation. Radziwill and Shelton used TWiki to create an easy to use system to managing software development, featuring advanced functionality, such as automatic creation of parent-

children relationships between documents (Radziwill, et al., 2004). Yang et al developed an elaborate TWiki application for requirements gathering in software projects, and have made multiple studies on it. The application used TWiki forms to create user interfaces for gathering data and uses automatic searches of form data to reorganize the information in the wiki to suit the users need. (Yang, et al., 2008) (Wu., 2010). Ben-Chaim et al also used TWiki and developed additional functionality to help software developers collaboratively organize reusable software components in the wiki. (Ben-Chaim, et al., 2009).

Thus it appears that TWiki or a similar wiki can be used to create advanced applications that can also be designed to be easy to use and make actual wiki use easier. However, as the wiki markup used to create the applications can be difficult, they often need to be incorporated in templates. This also means that the ability for everyone to edit everything in the wiki, especially the way the applications work, may be compromised. (Wu., 2010). Someone also needs to have the technical knowledge to be able to introduce the applications in the first place. Still, Kenney recommends structuring repetitive behavior to increase the usability of wikis by also using applications (Kenney, 2008).

4.4.8 Improving the interface

Holtzblatt et al claim that improving the interface of a wiki is a quick way to get users to contribute more. (Holtzblatt, et al., 2010). It is possible at least in open source wikis to alter the overall user interface of the wiki. This requires at least basic programming skills, although there may be alternative interfaces already available, such as there are for TWiki, which can be implemented easily.

If it is possible to improve the interface by modifying it, it is necessary to first identify what problems there are in the user interface being used. When analyzing the interface for improvements, generic information system user interface assessment criteria can be used, such as ones introduced by Nielsen (Nielsen, 1994). The interface should be esthetically pleasing. Symbols used to describe functions should be easily recognizable, including the text labels used to describe functions. Actions should be visible to the users immediately and the system should

communicate what state it is in to prevent confusion. Quick reaction time of the system is important to keep the users concentrated. The functionality that is used most frequently should be the easiest to find and be conveniently placed. (Nielsen, 1994). In case of wikis there are many frequently used functions. For information discoverers, the search function is very important. Information reorganizers should be able to easily move pages to different places in the wiki. Content creators and editors use the editing function the most and it should also be easy to find.

One way to approach the interface improvements is increasing the familiarity compared to other systems, as is common in open source software in general (Nichols, et al., 2003). General usability theories also suggest that familiarity in how the interface of an IT system works is good from the user's perspective as it for example reduces need for additional training (Sinkkonen, et al., 2006). Sun et al tried using a Microsoft Word based tool for online collaboration. Although it was not a wiki, for example lacking possibility to link between documents, it was still somewhat similar, being an online collaboration system used by multiple users. It was found that the end-users felt the system was very easy to use due to familiarity with the tools they already knew how to use (SUN, et al., 2006). The WYSIWYG editors in wikis, introduced earlier, can especially benefit from these findings. It should be beneficial to make their user interface similar to traditional office tools.

5. THEORY

This chapter focuses on finding a theory to be used in the empirical part of the thesis where improvements to wiki usability will be made and their effect will be assessed.

5.1 Theories used to assess wiki use

The theories that have been used before to in wiki research will be reviewed to find out if there already is a suitable theory to use in the empirical part.

5.1.1 Technology Acceptance Model

Technology acceptance model proposes that the *perceived usefulness* and *perceived ease-of-use* of an information system affect the user's decisions to start using an information system. (Davis, 1989). Cooney used the technology acceptance model in order to assess the appeal of wikis. (Cooney, 2006). She found that for example in Wikipedia, the *perceived usefulness* is perceived to be great. It counters the low *perceived ease-of-use* experienced by the users. While these findings do support the premise of this research, the Technology Acceptance Model is not suitable for addressing the problem at hand, as the wiki is already used by the users in the case company. However, the focus on usability can be seen as attempting to increase the *perceived ease-of-use* of wikis which also leads to increase in *perceived usefulness*, as they both can be thought of as components of usability.

5.1.2 Model of wiki technology diffusion

Based on the Diffusion of Innovations theory, Hester & Scott created a model of wiki technology diffusion. Their model consisted of five propositions of things affecting wiki diffusion in organizations. First two were related to how the organizational culture views change and how the users see the wikis as being compatible with the culture. A need for ad-hoc or multi-person collaboration affects the user's views positively. Third proposition is how the users see wikis offering advantages compared to other tools. The fourth is related to usability, focusing on how complex the users feel the wiki is. Finally, the fifth proposition relates to achieving a critical mass of users. This is because Hester& Scott claim that wikis depend on the community to

survive. (Hester, et al., 2008). This theory can be used for monitoring wiki adoption, but is not suitable for assessing improvements in a wiki that is already being used.

5.1.3 Personal Innovativeness in the Domain of Information Technology

The Personal Innovativeness in the Domain of Information Technology [PIIT] theory was first devised by Agarwal and Prasad. It suggests that the personal innovativeness of users of IT systems moderates the effects between perception about an innovation and the intent to use it (Agarwal, et al., 1998). Hester tested whether the theory applies to wiki users. It was found that wiki users seemed to have an increased level of personal innovativeness in IT. The moderating effect was quite large for users of wikis compared to those of other knowledge management systems. (Hester, 2010). While this theory might explain why some people are eager to use wikis with bad usability, it cannot be used as a theory to assess the effects of improving the usability of wikis. What PIIT could be used for is explaining why there has been only little attention paid to improving wiki usability and why there is a tendency for some users to be willing to spend their own time to install unofficial wikis, as explained earlier.

5.1.4 Delone and Mc Lean Information System Success Model

Delone and Mc Lean IS Success model includes components that can be used determine the success of an information system. According to the updated version of the model, information, system and service quality affect the users' intention to use the solution and their satisfaction, which results in net benefits. For more on the model, see (DeLone, et al., 2003). Trkman & Trkman used the model in a case study to find more about the benefits and difficulties of using a wiki as an intranet solution. They also modified the model to include two types of use, passive use and active use. (Trkman, et al., 2008).

While in this study it is assumed that the wiki is used at least somewhat actively, although with some using it only for document storage, the original model nor the modified one by Trkman & Trkman cannot be applied directly in this study. However, four of the components from the Delone and Mc Lean IS Success Model will be partly used in the framework formed in this study. These are *Information quality*. *System quality, User satisfaction* and *Use*. Due to only partial use

of some similar components, the framework formed in this study later will not be considered a revision of the Delone and Mc Lean IS Success Model.

5.2 Building new frameworks

As no suitable existing theory for assessing a situation where the usability of an existing wiki is improved to encourage more contributions to the wiki was found, it was necessary to start planning new frameworks about the related issues.

As discovered in the literature review, it has been identified that there are multiple issues with wiki usability, and things that some researches take for granted as being easy for users of wikis can in fact be difficult. As early as 2006 Kickmeier-Rust suggested that there is a need to focus on usability engineering of wikis to improve the usability of all elements in wiki interfaces, including wiki editors and methods used to add structure (Kickmeier-Rust, et al., 2006). As was found in the literature review, there are various methods to improve the usability of wikis. It thus seems beneficial to test these methods and see if they can really help make wiki use easier and if that also encourages more contributions. There is however no theory for dealing with issues related to a situation where a researcher intercepts a wiki that is already being used and tries to improve its usability.

As discovered previously, wikis are popular in companies. It may seem paradoxical to claim that there is a need to improve the usability of a widely used tool as it would be irrational for companies to use tools that users found difficult. But as has been discovered earlier, there is a tendency for wikis to be introduced to a company by a group that are especially enthusiastic about them and some users might be ready to dismiss the bad usability in favor of the innovativeness of the wiki as a technology. The enthusiastic group can easily demonstrate where a wiki is good at and, having learned the syntax, claim that is also easy to use. When the wiki is taken into common use, some users might found it hard to use, causing various issues which make using the wikis in the wiki way difficult. The problem that will be addressed by improving the usability of wikis is thus not only about increasing the use of wikis but also about making it

easier for all employees to use a wiki in a more efficient way. This means being able to produce content in the wiki itself.

The basic premise is thus that improving wiki usability will lead to better and more use of wikis. To be able to measure the effects, a framework for describing issues resulting from bad usability of wikis as well as a framework to describe issues that are resolved by improving the usability is formed, consisting of propositions.

Based on the literature review earlier, it is proposed that if wiki usability is found to be bad and the wiki is still used as a part of daily work process, it will cause problems (proposition 1). It has previously been found there is much functionality in a wiki that can be hard for users to use, even the basic means to add or edit content. Some users may thus find that the wiki is too difficult to use for doing work. In some cases this has caused companies to stop using wikis altogether (Jesdanun, 2004). However, if an organization continues to use a wiki with low usability, multiple issues arise. The active users of wikis, who are required to use the wiki as part of their work processes, can be divided into two categories depending on how they use the wiki, with each category of users affected differently.

A segment of the users who are not comfortable with using a wiki to create content may use other tools for doing work (proposition 1.1). They are still able to also continue using the wiki. This is possible because documents made with other tools, which are used individually, can be posted to the wiki in their original format as attachments. This has been found to occur in case studies, such as by (Da Lio, et al., 2005). This way of using a wiki also means that the IT department, for example, may still think that the wiki is used a lot because user statistics show a steady stream of activity.

For example Louridas (Louridas, 2006) highlighted that only little potential of wikis is being used if it is just used to store documents as attachments. Munson also found that using attachments limits the users' willingness to work together on documents (Munson, 2008). Thus when most work is actually done using other tools and only a few actually use the wiki, it means that only a limited number of contributors take part in creating content collaboratively. Also the

organization of the attachments put to the wiki is difficult and time consuming, the attachments cannot be linked with one another, and it requires extra effort to modify their contents. Thus it is proposed that using other tools to create content and posting it as attachments to the wiki leads to limited benefits of the wiki way of working and also causes increased internal transaction costs (Proposition 1.3).

There are also case studies that show that even despite experiencing difficulties with wiki usability, another segment of corporate users still prefers to use it for actually doing work because of the benefits they have perceived compared to other tools, such as in case studies by Munson (Munson, 2008) and Da Lio et al (Da Lio, et al., 2005). What bad usability of a wiki means for these users is that they may for example not be aware of what advanced functionality there is available in the wiki to assist them in their daily work (Proposition 1.2). Examples of this include not knowing about the advanced functionality to structure contents in the wiki, for example by using parent and children relationships or tags and the use of templates, as found by Kickmeir-Rust et al (Kickmeier-Rust, et al., 2006). Hard to use wiki editors can also lead to doing work in the wiki itself taking an unnecessarily long time to complete.

As amount of content in the wiki grows, information also becomes harder to find without proper organization, a problem referred to as proliferation, especially if users are unaware of advanced methods to structure content. (Happel, et al., 2008). Also the attachments mentioned earlier contribute to proliferation, as information is scattered across wiki pages and attached documents that need to be downloaded separately and usually cannot be searched using the search functionality in the wiki. This makes seeking information more difficult for all users of the wiki, including those who are not contributing to it.

Thus it is also proposed that the continued use of a wiki with low usability by some users to do actual work in the wiki will also result in limited benefits of wiki way of working and leads to increased internal transaction costs (Proposition 1.3).

The resulting framework can be seen in figure 1 below.

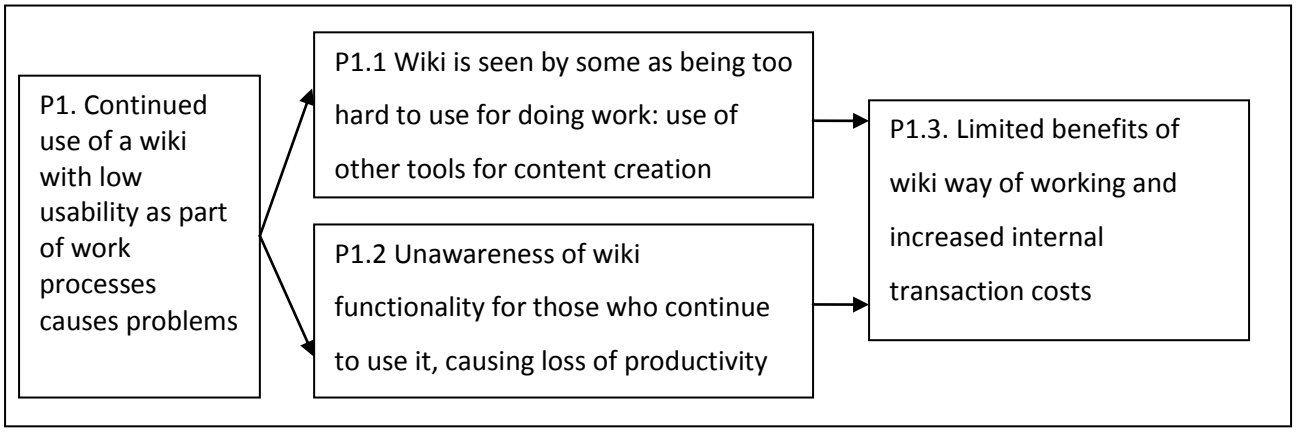


Figure 1: Conceptual framework of problems resulting from the bad usability of wikis.

The similarities of this framework to Delone and Mc Lean IS Success model (DeLone, et al., 2003) can be recognized. The framework can also be seen as a model of what results if the *system quality* of an information system is bad and it continues to be used, resulting in bad *information quality* and low *user satisfaction*, decreasing its *use* and also leading to lost productivity. However, the framework goes into more detail, focusing on the special properties of wikis, and, focuses on usability. The *system quality* is also the only component treated as being included in the original IS design, as in the case of wikis the *information quality* is something that can only be assessed as users actually use the system to add the content. The focus on usability can also be seen as using the *perceived ease-of-use* and *perceived usefulness* components of the Technology Acceptance Model, although in usability these are treated as one component, the usability. (Davis, 1989). Thus while this framework is new it uses some key components from established IS theories as a basis.

In research it has already been shown that once users learn more about how to use the wiki, they will use it more for doing actual work and participate in doing work collaboratively together (Da Lio, et al., 2005). In addition to training to users to use a complex information system, it is also possible to make the information system easier to use and reduce the need for training (Sinkkonen, et al., 2006). Thus it is proposed that if the usability of wikis is improved, the previously mentioned problems related to wiki usability can be resolved (proposition 2).

As a result of usability improvements, the wiki can be an easy tool for creating content leading to more work being done actually in the wiki (proposition 2.1). This is based on findings by Arazy et al according to which people are more eager to contribute the wiki as soon as they learn how to use the wiki (Arazy, et al., 2009). Andersson et al found that most people that used a wiki that was easy to use from start were willing to do work in the wiki itself (Andersson, et al., 2007). That means that more contributors will take part in content creation in the wiki as it becomes easier to use.

It is logical to assume that as various wiki functionalities become easier for users to user, or even recognizes, more employees will also be aware of advanced wiki functionality and can actually use it, assuming the usability enhancements are done well. This can lead to users for example organizing data collaboratively using tags or using automation tools available in the wiki, such as templates, to make their daily tasks easier. As a result, information can also be found more easily, also benefiting those who are not actively participating in the creation of wiki content. A more practical benefit is that content can be created in less time than in a wiki with bad usability. It is proposed that similarly to earlier general findings on improving usability of information systems, all this leads to increased productivity (proposition 2.2).

In organizational context, the improvements to wiki usability mean that more employees can realize the benefits of the wiki way of working, which were defined earlier. An organization can also reduce its internal transaction costs by making the wiki an easier tool as content creation takes less time and information becomes easier to find for everyone (Proposition 2.3).

It was also discovered that there seem to be many implementation issues regarding wiki use, such as the need to have wiki champions and a lot of training for users. If the wiki is made easier to use, the need for both additional champions and trainings is at least reduced, and the positive features of wikis are easier for users to identify. The need for less training has been found to be true already in research on the effects improving the usability of other information systems (Donahue, et al., 1999). It also decreases internal transaction costs.

The resulting conceptual framework can be seen in figure 2.

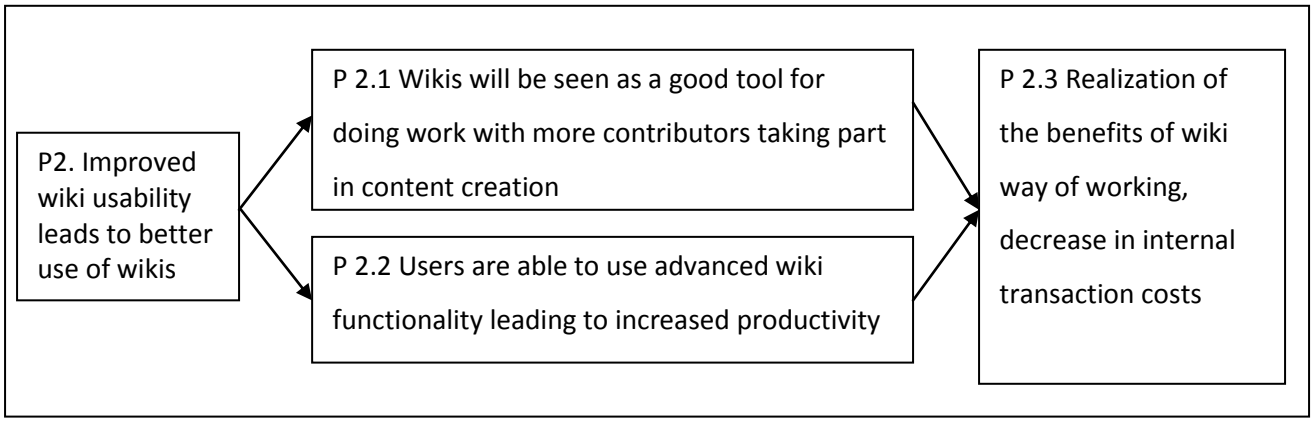


Figure 2: Conceptual framework of issues that can be resolved by improving the usability of a wiki.

Similarly to the earlier framework, this one can also be seen as using components similar to the Delone and Mc Lean IS Success Model (DeLone, et al., 2003) by focusing on what results if the *system quality* of an information system is increased, proposing that it results in *increased information quality* and *user satisfaction*, thus increasing the *use* of the information system. However, this framework goes into more detail, focusing on the properties of wikis and presents *system quality* as a component in increasing *information quality* and not treating it as something originally included in the IS system design, thus differing from Delone and Mc Lean IS Success Model. Similarly, components of the Technology Acceptance Model can also be recognized as the focus on increasing usability can be seen as attempting to increase the wiki's *perceived ease-of-use* of which also leads to increase in *perceived usefulness*; although as stated earlier usability includes both of the components. Thus while this framework is new, similarly to the earlier framework, it uses key elements from established IS theories as a basis.

The validity of the frameworks and the proposals included will be tested in the empirical part of the study.

6. EMPIRICAL PART

To test the validity of the framework, an empirical research was conducted at a case company where the usability of an existing wiki is improved, and the effects were observed by the researcher.

6.1 Research method

The empirical part of this thesis uses the Action Design Research method (ADR), by Sein et al (Sein, et al., 2011). The ADR method aims at tackling two issues at the same time by creating and reviewing ensemble IT solutions built for organizations. The first issue is how to deal with a difficulty that has been found to be occurring in an organization by interfering with the issue and then reflecting upon and learning from it. The second issue is building an IT solution aimed at solving the found difficulty and reviewing how successful it was. This results in a research method that is according to Sein et al focuses on "building, intervention, and evaluation of an artifact that reflects not only the theoretical precursors and intent of the researchers but also the influence of users and ongoing use in context".

According to Sein et al, some critical issues must be dealt with because of the ADR method's concentration on ensemble artifacts. The evaluation phase of the built IT artifact cannot be done only after the building phase and it is difficult to engage in systematic efforts for evaluating the solution. Depending on the system, there is also a need to specify the type of innovation in question. As an answer to these issues, the ADR method involves four stages. As the ADR method is fairly new at the time of writing, the stages will also be presented next in more detail.

Stage 1 of ADR is Problem formulation. A problem found in an organization is identified and conceptualized by the researcher, and also tentatively generalized. The problem is then used as a basis for innovation. Long-term commitment from the organization is necessary. Two principles are followed, practice-inspired research, which means generating knowledge as a result of dealing with the problem and theory-ingrained artifact, which means that theories should be used to evaluate the problem.

Stage 2 is Building, Intervention, and Evaluation (BIE). Based on the problem found in stage 1, an initial design for an IT artifact is made, and then further evolved as an iterative process based on user feedback. This research uses an IT-Dominant BIE, where multiple versions of a system are evaluated and developed, with each major version being introduced to a wider audience. The principles used in this part are reciprocal shaping, which means that a problem is solved step by step iteratively, mutually influential roles, which means that mutual learning occurs, and authentic and concurrent evaluation, which means that the developing solution is continuously evaluated.

Reflection and Learning is the third stage. It is a continuous process that occurs at the same time as the first two stages. It means critical evaluation of the research theories, the problem definition and the solution being created to ensure that knowledge is gathered continuously during the ADR process. The principle that is followed is guided emergence, meaning that a clear picture of what is occurring is formed by analyzing even the smallest pieces of information in a larger context.

Formalization of Learning is the fourth and final stage. What was learned during the project is generalized so that it could fit into a generalized area of problems. Accomplishments are outlined and also the solution is generalized and the implemented solution is analyzed in order come up with design principles for dealing with similar problems. The principle used is generalized outcomes.

6.2 Introduction to the case

The case company is the IT department of a large multinational company operating in the field of communications. The study is being made in a department dedicated to creating certain types of IT solutions for one specific area. There are about 100 employees working at the department.

The department uses a wiki as a place to store and create product and project documentation for the IT solutions that it is maintaining and developing. The wiki was chosen as the only documentation method to use in October 2009, and in March 2010 all of the existing documentation, which were stored in a traditional document management system, had been transferred to the wiki. At the start of the research there were 268 topics in the entire wiki.

Users had received only a little training about how to use wikis, but links to self-study material about how to use the wikis were provided. There was also a motivational document that contained reasons why the wiki was chosen. The reasons included transparency, ease of access, linking, searching and easy content creation and editing. However, despite the fact that existing documents had already been converted to the wiki format, a former product manager of the product commented that there had been many problems with getting people to use the wikis. (Discussion 1, 2010). As the wiki had already been chosen as the only tool to use for documenting, an effort to analyze the reason for the problems and to come up with possible solutions was later approved, resulting in this thesis. A long term commitment for the project was received, thus securing the commitment required for completing the ADR process (Discussion 2, 2010).

6.3 Initial problem Formulation

6.3.1 Analysis of the current wiki

The case company uses a wiki system called TWiki. It is much more advanced than the original wiki. TWiki is referred to as a structured wiki, as it has the capability to include structured data stored as forms alongside wiki documents. It also has other advanced functionality, such as the ability to create wiki programs, a lot of ready-made plugins and template capability. In this section it is analyzed whether there are problems with the usability of the current wiki and if proposals in the framework presented earlier are found to be true in this case company.
The usability of TWiki has been found to be low in multiple studies. However, the company has created its own look for the wiki used, making the previous studies on TWiki usability unusable for this case, expect for the wiki markup which has remained the same.

It appeared that the wiki was not being used efficiently. A lot of files were being posted to the wiki as attachments instead of doing the work directly in the wiki. These files were mostly created with Office tools that are used individually, such as Microsoft Excel and Microsoft Word. As was previously discovered, the posting of attachments instead of generating content in the wiki results in lack of benefits from wiki way of working, as users are much less likely to work on the documents together. Over the course of the wiki use, 2077 files had been uploaded to the

wiki. During the same time, 6257 edits had been made. This figure includes adding attachments. Thus 33% of all edits had been file uploads. It is a significant number, as the number of edits also includes all the little alterations made to the actual wiki content. These finding support proposition 1.1 in the framework.

Evidence of unawareness of even the basic wiki features was discovered. The clearest example of this is that recently a user had added a table to every "significant" document requiring every user who was edited the document to write their name, time of edit and what they had modified in a table that was placed on top of the page. The wiki could in fact have done this by itself, which meant that this manual process was unnecessary, leading to lost productivity. From a usability perspective it seemed clear why the user who made this request had not discovered the revision control feature, even by accident. The feature that compares wiki revisions was placed on the bottom of every wiki page, and was only indicated as a simple character, <, placed alongside listed wiki revisions. For those who have no knowledge of a comparison feature existing in a wiki, it would be very difficult to figure out that the < symbol means comparing revisions. The lack of knowledge about both these features was later confirmed in discussions with the users. Some users also reported not knowing that there is a search function in the wiki. The function was placed in the lower right corner of the interface, and was not visible without scrolling, leading to users not discovering it. (Discussion 8, 2011). These findings support propositions 1.2 and 1.3 in the framework.

Although TWiki has a lot of advanced functionality, no evidence of anyone using the functionality was discovered in the wiki. A template had still been made for using IT blueprints and the template was even named according to the standard used for TWiki templates. However, the template page also contained instructions for everyone to view the wiki markup of the template and copy-paste the contents if new IT blueprints were added to the wiki. Thus it was not utilized as a TWiki template, when it would have been use as a basis for new pages, without having to use copy-paste operations. These findings give further support to proposition 1.2

There had been some attempts made to categorize the wiki pages. Four main categories had been created, each containing three sub categories. Thus in total twelve page categories were available. Proliferation was still evident. Some of the page categories had a wiki page where links to pages

were to be found. A few of the links had also been placed on the front page, under a subheading that contained the category name. There was thus no consistency regarding how categories had been defined, and finding all pages related to a specific category required visiting many wiki pages. This also supports proposition 1.2.

In TWiki, it is possible to use parent-children relationships to link pages to categories. Even though there were some specific category pages for content made in the wiki, most of the pages had not been attached to them. This is likely because of unawareness of the parent-child categorization function available in the wiki. Lack of proper categorization meant that for example site maps could not be used to locate a page in the wiki. There was also a tagging function available in the wiki. However, no tags had been attached to the pages in the wiki. Thus it was not easy to find information in the wiki. This supports both propositions 1.2 and 1.3.

Creating a new page, partially due to the previously mentioned ways to categorize the pages using links on multiple pages, was also difficult. Even if a user was aware that Camel Case can be used to create a new page to the wiki users would have to remember to manually place a second link to another page to ensure consistency as page links were placed both on the main page and the category page. As was already discovered, inconsistencies were already evident. On the other hand, there was also a wizard available in the wiki to create a new wiki page without having to know about Camel Case. Using that method, users would have to remember to place links in the wiki or there would be no link to the page. This supports proposition 1.

It was discovered earlier that a WYSIWYG editor is of great benefit in wikis. In the wiki investigated, such an editor was available but its usability was low. The startup time of the editor was found to be 30 seconds on average. According to Nielsen to keep the user focused on interacting with a computer, an information system needs to be able to respond in 10 seconds. Otherwise, as is the case here, the user turns attention to other issues while waiting. (Nielsen, 2001). On the other hand, the raw text wiki markup editor was found to start on average in three seconds. Although this was enough to keep users focused on the task they are about to perform, it is still not enough for the users to get a feeling of seamless operation. A more serious concern with the WYSIWYG editor was that it could also destroy the contents of the wiki pages. Although the contents could be retrieved from version history, the edits the user made would still

have been lost. Multiple pages in the wiki included warnings not to use the editor because of this problem. These findings support proposition 1 in the framework.

Adding pictures was not easy in the raw text editor. The process of adding pictures consisted of many parts and it also required the user to have some basic knowledge of Hyper Text Markup Language. The WYSIWYG editor did contain a somewhat easier functionality to add pictures, but the raw text and WYSIWYG editor both shared a requirement to convert the pictures to a format that could be seen by web browsers. This meant that for example charts created in PowerPoint or Excel had to be converted to a format where they could no longer be edited easily and thus duplicate copies had to be stored to ensure easy the editing of the pictures and charts. Thus it was not surprising to find that many of the attachments posted to the wiki were files that contained a lot of images. This finding supported proposition 1.1.

Thus to conclude the problem formulation, it was found that the wiki was hard to use (P1) and as a result many were using other tools for content creation (P1.1). Those who did use the wiki did not utilize much of the useful wiki functionality, and instead used measures that took more time unnecessarily (P1.2). Information in the wiki was difficult to find and only a few participated in collaborative knowledge creation. Thus only limited benefits of wiki way of working were being experienced and wiki use also increased internal transaction costs, for example due to time it took to add an attachment to the wiki because of the multiple steps involved (P1.3). Thus support for all of the propositions regarding the effects of bad wiki usability was found. It seemed clear that there was a problem waiting to be solved by improving the usability of wikis.

The class of problems found could thus be identified as usability problems. The ADR method seemed suitable for this class of problem as general usability research methods, such as heuristics evaluation, also recommend using multiple participants to test systems to assess their usability (Nielsen, 1994). The ADR method could also be used to evaluate the effect of the improvements to be made.

6.3.2 Expected issues

In addition to the proposals introduced in the framework earlier, some other issues regarding wiki use could also be expected to appear, based on findings in the literature review made earlier.

The wiki way of working may not be viewed positively by some managers. At the case company there had been very little training about the wiki way, so managers would likely be unaware of the collaborative knowledge creation in wikis and why transparency is beneficial. It could be expected that there would be some resistance to the delegation of control to the users. Lack of training also meant that the awareness of wiki functionality was entirely based on the usability of the wiki, making the users at the case company good candidates to test the validity of the proposals.

Contributing information together could have also raised some issues. As was discovered earlier, users might feel hesitant to edit each other's work. There could have been for example issues regarding identification of the contributor of material as it had been made collaboratively.

Wiki champions could also appear. Especially as this research is conducted in the IT department of a company, it is expected that there are people who are very interested about new technology. As earlier research has found that many technically oriented people find wikis very interesting, those people might prove to be more active users of wikis.

6.3.3 Measuring the effects of the intervention

Wei et al suggested that researchers who study people's behavior in wikis could utilize logs that wikis record as a tool in wiki usability research and special programs could be written to analyze the logs. (Wei, et al., 2005). This approach was chosen in this study, although it was not necessary to create additional programs as the wiki platform used automatically stored a lot of useful statistics about how the wiki was used.

The statistics gathered by the wiki system showed the number of all modifications made to each wiki page, including minor alterations and file attachments. However, as the main aim of the usability improvements was to increase the number of contributors that edit documents directly in

the wiki and not the number of edits, this was not a problem. The wiki system stored a new revision of each wiki page when a new person edited a document, so it was possible to track how many employees had contributed to a certain page from revision history.

The wiki also had a revision comparison functionality that could be used to show whether or not employees were doing the work in the wiki itself or not. It gave the possibility to compare different revisions of a wiki document to see what modifications had been made between each revision. This allowed the researcher to see how probable it was that the information in the wiki had been actually been generated in the wiki. A large difference between each version and low number of revisions could suggest that information was copied from another source and actually edited elsewhere.

6.4 First phase

6.4.1 Problem formulation

As this study follows the ADR method, the intervention process was first started for a smaller team that used the wiki to manage agile software development projects. Because the team appeared to use a wiki as a part of their normal working practices it was deemed suitable to start the wiki usability improvements for them, as possible results could have been shown quickly. There were 10 to 16 members in the team based on what skills were required during a sprint. Although the team worked on software development, there were also a couple of non-programmers working on each sprint.

As told earlier, it was discovered in a study that using wikis in programming projects is one of the two most common activities that wikis were being used for (Majchrzak, et al., 2006). It was thus possible that others too could benefit from any findings in improving the usability of a wiki for programming projects. It was also expected that generalization of findings would be easier. This team was thus found to be a very suitable target for the first phase of the ADR process.

It was necessary to analyze the team's wiki pages and their behavior in addition to the overall analysis described earlier to be able to know where to start. The team that was targeted for the

first phase had its own pages in the wiki where information about the software projects the team was working on was stored. At the time of the study, there were two ongoing sprints, both following the agile method. A wiki page was created for every sprint.

The sprint pages contained all the items being done in the sprint. They were stored as a large table located on the wiki page. Items were being updated during the sprint. Each row in the table contained information about how complete an item was, a description of what is being done and who is assigned to do the item. There was also statistical information about the sprint progress which had to be calculated manually, and as a result some errors were discovered in the statistics provided.

As was previously discovered, the wiki markup for more complex items such as tables is quite difficult. During the sprints, only one member of the team, a programmer referred to from now on as SM, had contributed almost all of the edits to the pages. The difficulty of editing the table meant that only one member had learned the complete syntax for tables to be able to both create and edit the content, as was confirmed by the users. (Discussion 3, 2010) Just one additional member, who was also a programmer, had also contributed to the sprint pages, but had done only a minor edit.

Unlike in the entire wiki, proliferation was not widely evident in these wiki pages. All the pages were properly linked to their parent categories. Links to the pages were easy to find. This might have occurs as a result of the wiki having only very few contributors, and not that many pages. Nevertheless, two different naming schemes were being used for the same type of sprint pages, making the pages harder to discover.

There was also additional information posted to the wiki pages of the team, such as test reports and instructions. However, these were not wiki pages, but files made with other programs, mostly Office tools, posted as attachments. Thus the wiki was also being utilized as a simple file storage platform, instead of a virtual collaboration space.

Similar to findings by Grudin and Poole (Grudin, et al., 2010), management expectations of using the wiki for effective monitoring of what each team is doing were also encountered, as the stated purpose of the wiki use was to let other stakeholders know about the activities of the team. Also

similar to the earlier case study, the wiki use by the agile team occurred in a somewhat ad-hoc fashion, preventing stakeholders getting any reliable statistics of the team's activities easily.

6.4.2 Building and Intervention

As it was discovered earlier there were usability problems found with the WYSIWYG editor available in the wiki. A new editor for the wiki was found which could have solved many of the problems. However, the installation of a new editor requires quite a lot of time and effort, such as testing, and due to these requirements it was not possible to install it during the first phase of improvements. Users were specifically instructed not to use the current WYSIWYG editor as it was slow and had a tendency to mess up the contents of pages.

The overall wiki user interface was also found to be lacking, but creating a new interface would have also been a time consuming effort, and although initial efforts to create a new interface were started during phase 1, it was decided that it too could not be implemented yet. Due to the difficulties in installing a new editor and the time it would take to create a new interface, another approach was taken to improve the usability the wikis so that it could be evaluated whether some usability improvements are by themselves enough to increase the contribution rate, and thus also justify increased investment in the area.

Kenney argued that a lot of value can be achieved for making it easier to perform repetitive tasks in a wiki. He argued that it is recommendable to use plugins available in a wiki to do that. Based on the analysis of wiki use done, it was possible to find many repetitive behaviors occurring in the wiki used by the team, which could be made easier with plugins. Thus this approach was chosen as one of the pillars for creating usability improvements. However, another pillar was also needed.

Ward Cunningham already suggested that it would be beneficial to seed wiki pages with information, such as templates. (Cunningham, et al., 2001) While in this case the pages had already been started, Ferreira and da Silva (Ferreira, et al., 2009) suggested that wiki templates could also be made by reverse-engineering by observing what users had done in a wiki. Then, based on the repetitive activity that had been found to occur in the wiki, the repetitive actions

could be made easier for the users of the wiki by including as much information as possible readily into the template. This approach was chosen as the second pillar for usability improvements in the first phase.

The researcher created templates to be used as a basis to create new wiki pages for sprints in order to encourage more contributors to take part in the wiki by making repetitive tasks easier. Those templates included plugins that could be used by the end users to make performing their routine tasks in the wiki easier. In a way this approach was quite similar to the one used by Ward Cunningham in the original wiki, which was also used to manage software projects that used the agile methods (Cunningham, et al., 2001).

Based on an analysis done based on the contents of earlier sprint pages, it was found that the following items were done repetitively in the wiki:

1. Adding new sprints
2. Adding new tasks to a sprint
3. Adding new items to a task
4. Editing existing items.
5. Calculating statistics about the sprints progress

The first repetitive task that was tackled was adding new sprints. It was argued that proliferation and the difficulty of link creation is such a big problem in wikis that it was acceptable to provide a new, more automated link and page creation process in addition to the original methods. The wiki pages were modified by providing a text box for users to create new wiki pages from the main page of the main page used by the agile team. These pages would automatically be based on the sprint templates which were to be created. As there were two sprints ongoing, two text boxes were created to be able to create pages belonging to a certain type sprint. This method to create new pages was more familiar to users of office tools and thus reduces learning effort on the user's side and also automatically placed the document in the correct category. The page names were given automatically, such as Sprint01, Sprint02 etc. The parent page of the sprint pages was also

automatically the page that was used to show an overview about the sprints. This improved usability and also prevented proliferation.

Desilets et al argued that providing a text box for users to create new pages in a similar fashion to Office documents is a wiki great usability enhancement in itself. However, they also argued that as it was necessary for users to manually add the link to the page later, it in fact created a new usability problem and also made it possible to have pages that are not linked. (Desilets, et al., 2005). This problem was observer earlier also at the case company. It was solved in the wiki used by the team by implementing a search routine that automatically searched and listed all the wiki pages created using the text box located on the page. This approach was similar to Buffa's findings about advanced wiki use (Buffa, 2006). As users could create two kinds of pages, belonging to each sprint, two search routines were placed that searched for pages belonging to each type of sprint, shown above the text boxes used to create links. This functionality thus removed the extra step required to create a link.

Adding a new task to an item (3) and editing existing items (4) were tackled first in the sprint template. Originally, all the tasks and items were stored in one large table. Holtzblatt et al discovered that when wiki pages contain tables or item lists, users are more likely to contribute together. (Holtzblatt, et al., 2010). This seemed contradictory in this case as the team in the study also had a table in their pages, but users were still not contributing. However, as discovered earlier, wiki markup for tables is difficult. To further complicate the effort, the tasks were stored as a large table which contained all the items. The code thus looked even more difficult and making a mistake could have resulted in the entire table being broken. In addition, there were many users who were not aware of revision control offered by the wiki, and were thus afraid to edit it because of a fear of messing the pages up. (Discussion 3, 2010). An illustration of wiki markup required to create a table is included in Appendix 1.

To make table editing easier, the researcher implemented the Edit table plug-in that made it possible to edit tables using a Graphical User Interface (GUI) on the team's pages. The installation was done by adding one row of wiki markup before a table that it was installed for. This plug-in was already installed at the case company, but the users were not aware of its

existence. The plug-in also removed the extra step of going to the edit mode in the wiki, and allowed the user to remain on the same page, which according to Nielsen increases user comfort (Nielsen, 2001). By clicking on a button placed on the bottom of the table, the table changed to an editable mode but the user still stayed on the same wiki page. It was also possible to add new tasks to an item in the editable mode. In addition, the plug-in also increased structure as it was possible to allow the user to select the status of an item from predefined values, such as work in progress or finished, making it easier to follow the progress of the tasks as it was ensured that the same terms were used all the time. The plug-in also did not remove the possibility of editing the tables using the wiki markup editor, so the option for power users to use their knowledge of wiki markup was still retained. Also, the problem raised by Wu about users not being able to control the behavior of the plugins (Wu., 2010) was thus avoided by allowing users to bypass the plugin. An illustration of table editing using the edit table plugin is included in Appendix 2.

The problem of adding new items (2) was dealt with next. As the code for the edit table plug-in would have been hard to replicate by the user, another plug-in was utilized. A new template for the comment plug-in, which was also already available in the wiki, was created so that it could be used to create new item tables automatically. An empty table, containing the edit table plug-in code, was inserted into the template. The creation of a new sprint item was made easier by adding text boxes and a button in the template. By clicking the button, users could insert a new item to a sprint.

The manual task of calculating statistics (5) was automated. A plug-in, similar to excel, was added to the table and sprint templates. It automatically calculated the statistics of each sprint item and task as well as the status of the sprint as a whole. In addition, to add further structure, some of the key figures which needed to be set manually for each sprint, such as starting date, duration and status of the entire sprint (which needed to be set manually because of the way the agile sprints work) were added as form data, which was explained earlier. This allowed those key figures to be shown everywhere in the wiki where it was desired using a search routine as described by Buffa (Buffa, 2006) and elimination of the need to do updates in multiple places. It was also something that Möller & Birn especially recommended for wikis used in software projects (Möller, et al., 2006). In the first phase, this data was automatically shown on the main

page of the team, in addition to the sprint pages to give an overview of activity occurring in each sprint. Storing key information as structured data also provided an opportunity to tackle the problem of wikis tending to become messy and chaotic and thus unappealing to managers as an information source, as was experienced by Gruding and Poole (Grudin, et al., 2010).

While it is true that it was not easy for end users to modify what statistics would be shown which was a concern presented by Wu (Wu., 2010), even the inventor of wikis, Ward Cunningham, felt it was necessary to create an additional program to gather statistics based on activity in sprints, and that it was not necessary for users to be able to modify what statistics are shown (Cunningham, et al., 2001). Thus it was decided that this was an agreeable compromise to make.

Finally, the template that was used as a basis for new sprints was finalized. General information, such as a table containing the members of the team and ready headlines for introductory sections to a sprint were added which were also found on every sprint page created so far, in addition to all of the other functionality described earlier. Thus all of the repetitive tasks could be automated and made easier to use by utilizing templates and plug-ins.

The templates that were created were a combination of creational and functional templates, as defined by Di Iorio et al and also explained earlier. (Di Iorio, et al., 2007). However, only the form template which was used to store structured data was created as a functional template with the rest being creational templates. As the creational templates provide complete freedom for the user to change the content of the page after it has been created, they were more widely utilized as the ability to edit everything is a key part of the wiki way of working.

To further enable the freedom of editing which was something Wu (Wu., 2010) feared might be lost by using plugins the wiki markup that was used to implement the plugins in the templates was commented so that the user could recognize which parts of the markup was used to control the behavior plugins. This is something that Haake et al suggested and also tested, although with mixed results (Haake, et al., 2005). It was hoped that this would be enough to prevent the users from accidentally deleting something while still allowing the users the possibility to edit whatever part of the page they desired.

The picture below shows the IT architecture of the wiki template:

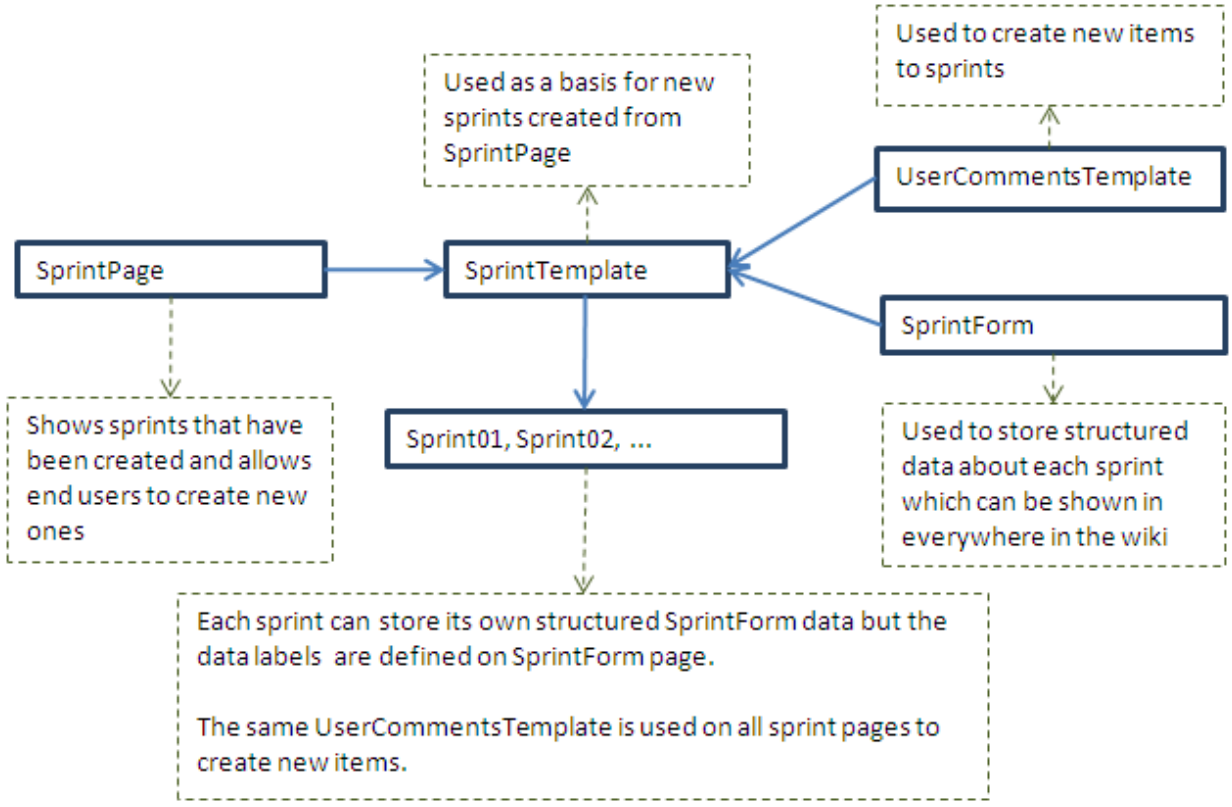


Figure 1 The IT architecture of the Phase 1 wiki pages

6.4.3 Adjustments made

As was expected, one manager in the group, PM, voiced concerns that making it easier to create and edit new pages might result in undesired actions. It came as news to PM that all pages in the wiki could by edited by anyone. After a discussion that involved explanation of the process wiki uses to log in each edit that users make, vandalism was no longer seen as a big threat. However, it was feared that some might start a new sprint by accident as the new way for sprint creation was found to be very easy. (Discussion 3, 2010). To meet this concern, another step was introduced to the page creation process. The users would have to click on “show page creator” link to reveal the functionality to create pages.

Already during the first presentation of the new features, the PM also stated that it would be beneficial to also do other types of documents in the wiki if they too could be made easier to create (Discussion 3, 2010). To make it easier for the team to try creating new wiki pages other than sprints, an “other documents” area was added to the main page of the agile team wiki. It contained a text box for page name and a button to create the page that could be used to easily create new wiki pages. The pages were also automatically searched for and shown above the text box, removing the need to create a link manually.

Two team members, PM and SM, who was the original contributor to the pages, also later made multiple suggestions on how to use the wikis more effectively, based on their own specific needs. In agile teams, it is quite customary that items are not finished during a sprint. Some of them might be moved to newer sprints whereas others will be worked on later. To keep track of all the unfinished items in various sprints, PM and SM suggested finding a way to mark the unfinished items in the wiki page of each sprint and then creating an overview wiki page that would search for those items and would also show the sprint they were left in and the reason why they were not being worked on at the moment. (Discussion 4, 2010). What was notable of this request was that it suggested utilizing such functionality of wikis that is not available in traditional productivity tools, such as Microsoft Office. This page was added to the wiki by the researcher. Some additional statistics were also added later on. It is notable that all of the suggestions came from the two team members PM and SM, although there were in total 19 contributors to the wiki. While SM was a programmer, PM was on the other hand not, so there seemed to be no difference in this regard between non-programmers and programmers, further adding to mixed results in earlier wiki research in this regard.

Word of the wiki improvements also spread out to two teams in other departments of the company who were also working with agile sprints. The teams had considered using commercial programs to monitor the progress of sprints, but chose to utilize the wiki template solution instead. The teams chose the wiki because of, according to them, greater transparency, easier collaboration and also the multiple customization possibilities compared to commercial ready-made tools. (Discussion 10, 2011).

6.4.4 Evaluation of the results of the intervention

The team's wiki use after Phase 1 improvements was monitored for five months from the beginning of October 2010 to the end of February 2011. The revision control future in wikis was used to track the number of participants in the wiki. The results are shown in the table below. The usability improvements were made for Sprint 3. There were two sprints going on at the same time, but as many team members were participating in both sprints, the contribution rates for the two sprints were combined into one.

"Contributing" is defined as a person who was made at least one edit to the wiki during a sprint and "Not contributing" as someone who has made no edits at all to a sprint page. Contribution rate is calculated by dividing the number of contributors during a sprint by the amount of the team members allocated to the sprint.

Sprint #	Contributing	Not contributing	Total	Contribution rate
Sprint 1	*1*	*9*	*10*	*10%*
Sprint 2	*2*	*10*	*12*	*17%*
Sprint 3	6	7	13	46%
Sprint 4	9	7	16	56%
Sprint 5	10	4	14	71%
Sprint 6	13	2	15	87%
Sprint 7	12	2	14	86%

Table 1. Contribution rates of each sprint.

The contribution rate is also presented graphically in the chart below:

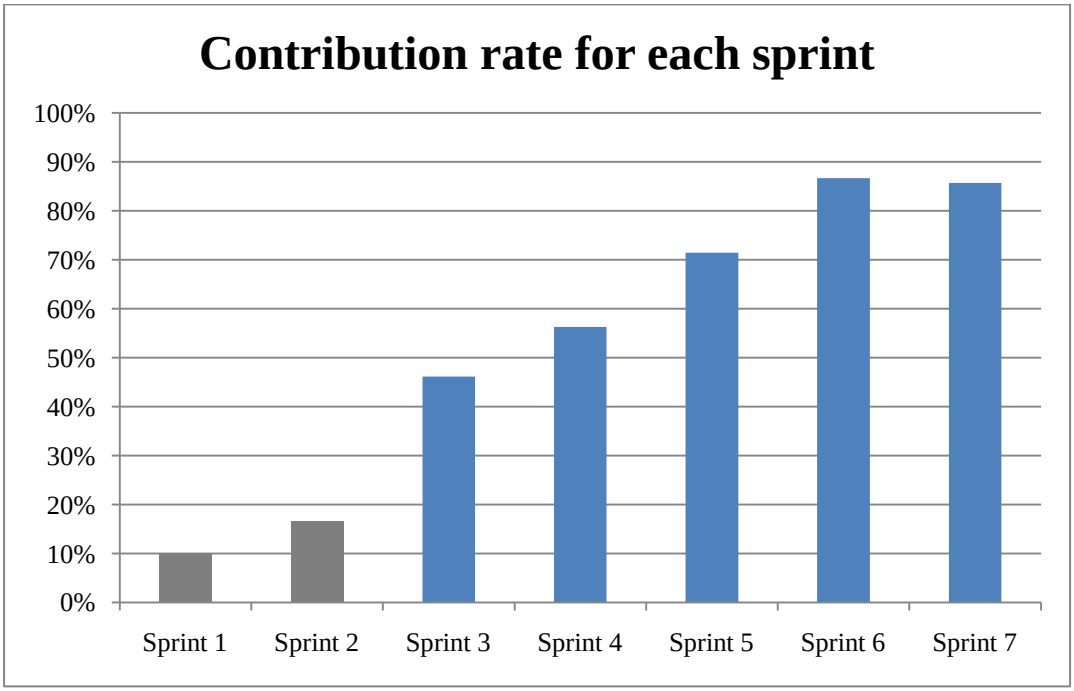


Figure 2 Chart of contribution rate per sprint

As can be seen from the table and chart above, the number of contributors to the wiki pages maintained by the team rose dramatically after improvements were made for Sprint 3. This increase also seemed sustainable. By sprint 6, all of the members of team who had been assigned tasks updated the progress of those tasks by themselves in the wiki.

It was notable that the manager of the team, in a performance retrospective made after the wiki improvements had been used for over two months, recognized the use of a “great wiki” as one of the key reasons that enabled the team to perform its tasks so well (Manager, 2011). The team members also unanimously found it great that the wiki was easier to use by everyone in their own sprint retrospective, which was also created in the wiki, using the other document creation functionality described earlier.

There was no difference found in starting to use the wiki after usability improvements based on whether the user was a programmer or not, as already in sprint 3 the new users included both programmers and non-programmers. Thus in this case it seems that the usability problems with wiki markup had prevented both user groups from participating in the wiki before.

Some problems remained. The two members of the team who did not make updates to the sprint wiki pages did their updates to another page of the wiki. That page contained only attachments posted by the two members and did not contain any actual content in wiki format. The author was also asked to by some wiki users to perform some basic wiki functions on their behalf, such as restoring previous versions of pages of the users on several occasions. The possible reasons for these problems are reflected upon later in reflection and learning.

Evaluation of possible compromises to the wiki way of working

The unique properties of wikis which enable the wiki way of working where identified earlier in the literature review. To ensure that these properties were not compromised as a result of the usability improvements, the effect of the improvements on the properties is analyzed.

Property 1: "Everyone can easily edit, create and summarize content in a wiki without having special technical expertise"

It can be admitted that by including for example buttons in the wiki templates, some of the wiki markup did get more complicated to edit for the end user. Users had to avoid destroying those special pieces of code while editing the wiki pages, although assistance was provided in the forms of comments in the wiki markup. However, users proved to be capable of inserting freeform text to the pages without accidentally destroying any of the advanced wiki functionality, so that it can be argued that with this case group of users, this property was only marginally compromised.

Property 2: "Wiki pages are stored and worked on online, reducing the need to use of additional communication tools and making sure that the newest version of document is always used"

No compromises to this aspect of wikis were made. In fact the usability enhancements increased the team's capability to reduce the use of additional communicational tools and to utilize the wiki instead.

Property 3: “Version control enables to follow up on the work progress and enables reverting of malicious or unintended edits if needed as well as enables to work on documents iteratively resulting in continuous learning."

No alterations to this aspect of wikis were made. However usability problems identified earlier meant that this property was not widely utilized by the team.

Property 4: “The wiki can be accessed from multiple locations and with multiple means, with the addresses and links pointing out to wiki pages remaining the same even if the order of the pages is reorganized.”

No alterations to this aspect of wikis were made.

Thus it can be concluded that there were only very minor compromises made to the wiki way of working with the positive effects experienced outweighing them.

6.4.5 Reflection and Learning

Based on the feedback received and the results shown in the statistics, the implemented improvements made editing the wiki significantly easier for most of the team members. This enabled the team members with assigned tasks to participate in the wiki by reporting the progress of their own tasks by themselves, instead of having to forward the information to SM first.

To find out the reason for the two members of the team not posting any data to the wiki, the contents of the documents they had attached to the wiki were analyzed. It was found that the documents they had added contained a lot of images which were presented as charts. As was discovered earlier, attaching images to the wiki was found to be difficult, and the images had to be attached in a format that did not allow their easy editing afterwards. No usability improvements were made for this part of the wikis user interface and thus it appears that usability

problems in this area were the reason for these two people not contributing to the wiki. This was also later confirmed by the users. (Discussion 5, 2011)

The basic wiki interface was previously found to be problematic for many wiki functions, such as revision compare, and was also not changed during phase 1. As a result of this, the users could not use this functionality by themselves and had to ask for help. Thus there were still usability issues remaining in the wiki after phase 1, some of which would be tackled in phase 2.

There was also increasing management attention to wikis. After reviewing the increased contribution rates, the templates used for this agile team and a preview picture of a new wiki interface, which will be explained in phase 2, the managers themselves said that as it seemed that it really is possible to make the wikis easier to use, they can be utilized in creating more transparent and collaborative working practices (Discussion 6, 2010). The ability to view key project data stored in a functional template anywhere in the wiki was also appealing to managers. Thus it seemed that adding structured data can also be used to increase the management interest in wikis and tackle the chaos that might result after a lot of edits to a wiki. New projects were being started where the main working tool would be the wiki. One of the projects ended up being used for the second phase of the empirical part. It provided an opportunity to improve the wiki usability more significantly, and also fitted the ADR method well, as it provided an opportunity to observe more users during phase 2 and also introduce more improvements.

Looking back at the original hypotheses, based on the situation before intervention, continued use of a wiki with low usability as part of work processes was found to result in the wiki being seen by some as too hard to use for doing work and thus other tools were used content creation, which in this case also continued to occur for the test reports as the usability related to their creation was not improved. Unawareness of wiki functionality for those who continued to use it was also found, especially templates, plug-ins and revision control, causing loss of productivity, as time was previously spent for example on manual calculation of statistics. Limited benefits of wiki way of working also seemed to lead to increased internal transaction costs, as the SM for example originally had to update the wiki alone, taking time from more productive activities. Thus all the

hypotheses related to continued use of a wiki with bad usability were found to be true in observing the group that used the wikis in phase 1.

Also the proposals related to what happens when wiki usability is improved were found to be true in this case. Improvements in wiki usability lead to better use of wikis. Wikis were seen as a good tool for doing work with more contributors taking part in content creation as the contribution rate increased significantly. Users were also able to use advanced wiki functionality leading to increased productivity and some even suggested their some improvements which were implemented. Realization of the benefits of wiki way of working lead to decrease in internal transaction costs as information the teams' activities was updated by team members themselves and also effectively reached the stakeholders. There was increased automation of repetitive tasks that would not have been possible without clever use of wikis, leading the project team to regard the use of a wiki as one of their success factors. It was also found that the usability improvements did not have any significant effect on the wiki properties that enable the wiki way of working.

As was expected, wiki champions also appeared. Two members of the team were the most active in coming up with new ideas to the wiki. In this case, both had been using the wiki already, and were now excited by the new possibilities the wiki had to offer.

6.5 Phase 2

6.5.1 Problem formulation

Phase 1 was successful in improving the usability of the wiki for one specific group of users of the wiki. However, many general problems remained unsolved. These included the usability troubles in the wiki user interface and the problems with the WYSIWYG editor found earlier. As the wiki was being used for many other purposes than agile sprints, more generic solutions to problems with wiki usability were still needed. As briefly mentioned already, a project was found which seemed to be a good opportunity to provide more generic solutions.

When discussing the wiki improvements with a manager, the manager suggested that these improvements could be utilized to make project documentation easier in the wiki. While it was

already a requirement to do documentation in the wiki for all projects, according to the manager the users had seemed unwilling to do that as most of the project documentation continued to be made with other tools. According to the manager, part of the reason seemed to be that although there were templates to make the project documentation in traditional productivity tools, those templates were not available in the wiki as it had not previously been known that there was a possibility to create wiki templates. Thus creating project documentation in the wiki would have required a lot of extra effort compared to other tools. Thus it was decided that project documentation templates would be converted to wiki format and tried first in one project. The project manager (PM from now on) was to be informed that there were ready templates in the wiki to use for project documentation. (Discussion 6, 2010).

Upon further investigation of current project documentation in a wiki it was discovered that many projects had not even uploaded the required documents as attachments to the wiki. Thus there was a lack of transparency in the projects, especially for stakeholders outside the project. It seemed possible that wiki could be used to solve this real business problem. As project management was found the second most common task that wikis were being used for in a large survey (Majchrzak, et al., 2006) it was also considered to be a good choice for the second part of the ADR process improvements as any findings could be generalized.

Unfortunately a new WYSIWYG editor, which would have made editing of certain items, such as tables, easier in templates without extra effort by the researcher could not be installed during this phase due to resource and time constraints. Because of this the project documentation templates needed to be specifically made easier to edit without the WYSIWYG editor by using a plugin, which would have been unnecessary if it had been possible to install the new editor in time. As a result of no improvements in the WYSIWYG editor and difficulties involved in including images it was also expected that some documents would still probably be created using other tools and would be posted as attachments to the wiki – although even that could have been considered an improvement to the state during the lack of transparency at the start of the project. As in Phase 1, users were also instructed not to use the current WYSIWYG editor as it was slow and had a tendency to mess up the contents of pages.

The approach to use wikis to increase information discoverability and add transparency to daily working activities also meant that information discovery should be easy for everyone. Those who seek wikis for information access the information through a navigational interface. According to Sinkkonen et al it is important that usability is the primary concern when designing the methods to navigate the pages. Actions should also be easier to identify (Sinkkonen, et al., 2006). As discovered earlier, the interface of the wiki was lacking in this regard. This problem was also tackled in phase 2.

6.5.2 Building and Intervention

As in Phase 1, templates were built but in addition a new interface for the wikis was also built and implemented.

6.5.2.1 Template creation

All of the project documentation templates were sought for and converted to the wiki format so that new wiki pages could be started based on those templates. All the tables in those templates were converted to an easily editable format using the edit table plugin to make sure that every user could easily edit tables, identified earlier as one of the most difficult parts to edit in the wiki markup language. This also made it possible to structure some of the information by for example providing standardized statuses in the tables for users to choose from for certain tables to ensure consistency, such as in assessing the severity of project risks. It was still possible to skip the forced requirements by using the raw markup editor, thus making sure that the wiki way of working was not compromised.

Generally in projects, there is a lot of data that is repeated in multiple documents, such as deadlines for the completion of certain phases, the actual completion dates, and the name of the project manager and so on. To make the editing of this data easier, it was stored in one place as form data and read from there to the entire wiki. Thus if for example the expected completion date of a phase in the project was changed, it would only have to be edited in one place. A total of 26 such pieces of information were stored as form data. This is similar to suggestions by Möller

& Birn (Möller, et al., 2006). The wiki markup required to read the information was placed in the project templates where that information needed to be shown.

Another feature which was added to the templates and stored as form data was allowing the users to state what the status of each document is. The status could for example be shown as “draft” or “work in progress” or “finished”. This was done in order to deal with possible reluctance of sharing unfinished work. Da Lio et al for example found this to be a problem with wiki use (Da Lio, et al., 2005) and it was hoped that this could be a solution to the problem.

As in Phase 1, the templates that were created were a combination of creational and functional templates. Also similarly to Phase 1 only the form template which was used to store structured data was created as a functional template with the rest being creational templates. As the creational templates provide complete freedom to the user to change the contents of the page after it has been created, they were more widely utilized also in this phase as the possibility for users to modify the pages freely is a key part of the wiki way of working. The codes placed in the templates to read the form data could also be removed freely by the users, thus also the functional templates could be removed from view by the users if so desired, further increasing the freedom to edit.

Finally, a project page template was also created which provided links to each document template that the users could simply start filling. This is similar to suggestions by for example Cunningham (Cunningham, et al., 2001) about seeding pages with content to ease the content creation effort. The template pages were named with names that fitted the purpose of each document, such as ProjectXRiskLog so that proliferation was prevented. The links to the documents were divided into sections depending on in which phase of the project they were supposed to be completed in. Status of each phase, and expected and actual end date as well as status of each document was also shown on the project’s home page in the wiki. All the facts stored as form data were also shown on the project page. This allowed the tracking of project progress at a glance, as well as the viewing of key information, increasing the usability of the pages for stakeholders following the project.

6.5.2.2 New interface

For phase 2, a new interface for wikis was also built and implemented. Holtzblatt et a suggested that a new interface is a quick way to get wiki users to contribute more (Holtzblatt, et al., 2010), so it seemed suitable to choose this as the other usability improvement method to use in addition to templates.

It was found that the case company had created web page templates that had been designed by usability experts, but for some reason they had not been utilized before in the interface of the wiki. Those templates were used in other systems already. These templates were utilized as a basis for a completely new graphical user interface for the wikis, created by the researcher. While the templates had been designed by experts, and thus could be assumed to be user friendly, each visible change to the end user was also analyzed based on the findings in usability research.

The following main improvements to the wiki interface were made:

1. Look and feel of the wiki was changed to be similar to other applications used in the company. According to Nielsen, a familiar looking interface is easier for users to understand from a usability perspective due to lesser cognitive load (Nielsen, 2009). Andersson et al also found that users also appreciated this in case of wikis. (Andersson, et al., 2007) Thus it was found to be more suitable to use an existing design than coming up with an entirely new one.

2. Search functionality location was changed so that it became easier to find. The search function was previously located in the lower right corner requiring users to scroll down the page to find the functionality. According to Nielsen, having to scroll down a page greatly reduces the changes of user finding any information not located in the upper part of a page. (Nielsen, 2001). As the search functionality was moved to be located in the upper right corner, it was notably easier to find and also consistent with other applications used at the company.

3. Wiki navigational menu was also moved upwards so that it became easier to find. Previously links to many wiki functionalities, such as RSS feeds or Recent Changes were located in the lower left corner of the page and required scrolling to be found, which as discussed above is bad from an usability perspective. The templates specified these to be located in the upper left, where they were seen by the user without scrolling and thus were easier to find.

4. Access to older page revisions and the revision compare functionality was made easier to find. Previously, this functionality was shown only as links to previous versions, with the look and feel of normal links. These were changed to appear as action buttons. In addition, a clarification text "View or compare topic revisions" was added. According to Sinkkonen, user has to be able to recognize a functionality before the user can use it and text is easier to understand than an image if the functionality is unfamiliar to the user. (Sinkkonen, et al., 2006). As this was a function unique to wikis, the clarification text was added so that the user could recognize what the functionality was. In addition, a link to the revision history function was added as an action button alongside other buttons in the upper right corner of the wiki.

5. Some terminology used in wiki interface was changed to be more similar to other applications. Nielsen suggested that terminology used in applications for similar functionality should be the same in different applications. This increases usability as it prevents confusion among the users. (Nielsen, 2001) The changes included renaming "Save" as "Save and exit" and "Checkpoint" as "Save" in wiki editor, so that they better reflected the behavior of common text editing tools, such as Microsoft Word. "Attach" in the interface was also changed to "Attach file" which is similar to terms used in e-mail applications such as Outlook.

6. An editing toolbar was added to make writing wiki markup easier. Based on Deslitets et al's suggestion (Desilets, et al., 2005) and the successful implementation of a similar toolbar in Wikipedia (Wikimedia Usability Initiative Team, 2010), the toolbar contained icons that users could click to insert wiki formatting commands without additional

knowledge of wiki markup. These functions included making bold and italic text, bullet point and numbered lists as well as different type of headings. Icons were designed to look similar to other tools to prevent user confusion.

The interface was only introduced to the wiki pages used by the project team in Phase 2 to allow its further development based on user feedback before taking it into general use. This is also the idea in the ADR methodology which was followed. It could unfortunately be introduced to Phase 1 wiki users which were partially observed at the same time. This was because it was expected that there might be technical difficulties with the new wiki interface which might have caused the wiki to become inoperable for these users: The wiki had become such an important tool for the users in Phase 1 that the users wanted to ensure that they were able to access it all the time. It was decided that after testing the new interface in the project in Phase 2, the other wiki users would then adopt it later (Discussion 7, 2010).

A wireframe model of the old interface is included in Appendix 3 and a model of the new interface is included in Appendix 4.

6.5.3 Adjustments made

Based on suggestions of the project manager, who had not used wikis before, more data was added to the "fact box" which contained data stored as a form in a functional template. Another suggestion from the project manager was a material bank page, where users could post links to material relevant to the project. Later a meeting minute template was also requested by the project manager. All of these suggestions were implemented by the researcher.

There was also a suggestion of adding a holiday calendar, which was traditionally done in Microsoft Excel to the wiki. This suggestion came from another member from the project team who had also not used wikis before. However, it would have been a major effort to convert that to be easily editable using the edit table plug-in, and it was decided that it would be waited until a new WYSIWYG editor was available before adding the holiday calendar to the wiki.

Somewhat surprisingly, no improvements to the new interface of the wikis were suggested nor were there any reports of problems found. This might have been due to the fact that it was similar to other programs used in the company, and thus familiar to the users.

6.5.4 Evaluation of the results of the intervention

The team was observed for two months from January 2011 to the end of February 2011. The phase 2 thus occurred partially at the same time as Phase 1. While the contributing authors in the wiki were mostly different than in phase 1, the stakeholders who followed the activity in the wiki remained the same.

The new wiki user interface received lots of positive feedback. The revision storing and revision compare feature were easier to be found, and their existence came as a surprise to all the 18 members of the project team. Many told that they had previously been afraid to edit wiki pages because of fear that they might destroy the pages' content without possibility to revert back to the old version. The revision compare feature was also received enthusiastically, as the team members realized it was no longer necessary to write down who had changed what in the document and when, as had to be done when word documents were used, since the wiki could do that automatically, and would also store every version. (Discussion 8, 2011). Thus users began to realize that there are lots of things available in wikis that can make their daily working life easier and also increase productivity.

One of the project team members had used a wiki a lot before and expressed frustration at the choice of a wiki as a work method. This was found to be as a result of difficulties encountered with editing tables. After demonstration of the easily editable tables, the person no longer expressed frustration and was instead delighted that tables, which were numerous in project documentation, could also be filled in and edited easily in a wiki. (Discussion 8, 2011). This suggested that as speculated by Cowan et al, a bad first user experience for wikis can be overcome with usability improvements introduced later (Cowan, et al., 2009).

All of the pages that templates had been created for were also actually done in the wiki. This was confirmed by comparing the revisions of each page. The project plan, for example, had grown gradually in 21 revisions from just a page template to a plan containing all the project related data filled in.

However, the documents for which templates were not created were posted as attachments to the wiki. Some of these were updated multiple times, so at least improvements in transparency to the project were achieved as even draft versions of some documents were posted.

As the official documentation tool for this team had been a wiki since November 2009, it was possible to compare the documentation of this project to another. The wiki documentation for an earlier project that the same team members had completed was found only after the improvements were made and put into action. A wiki project page had also been created for that earlier project by a team member. Both projects had used the same project documentation method which meant that the amount of documentation done during the earlier project was the same. However, the amount of project documents in wiki format and also project management documents posted as attachments to the wiki differed dramatically. In the earlier project, only three project management documents were visible in the wiki, whereas for the current project the amount was 24. It was later found out that six additional documents had been posted in another document management system, but no link to that system had been added to the wiki. Thus it can be concluded that it was possible to achieve a significant increase in transparency of project documentation by improving the usability of wikis:

Project	**Project management documents in wiki format**	**Project management Documents as attachments**	**Total visible documents in wiki**
Older project	2	1	3
This project	18	6	24
Increase	**800%**	**500%**	**700%**

Table 2: Amount of documents available on project pages

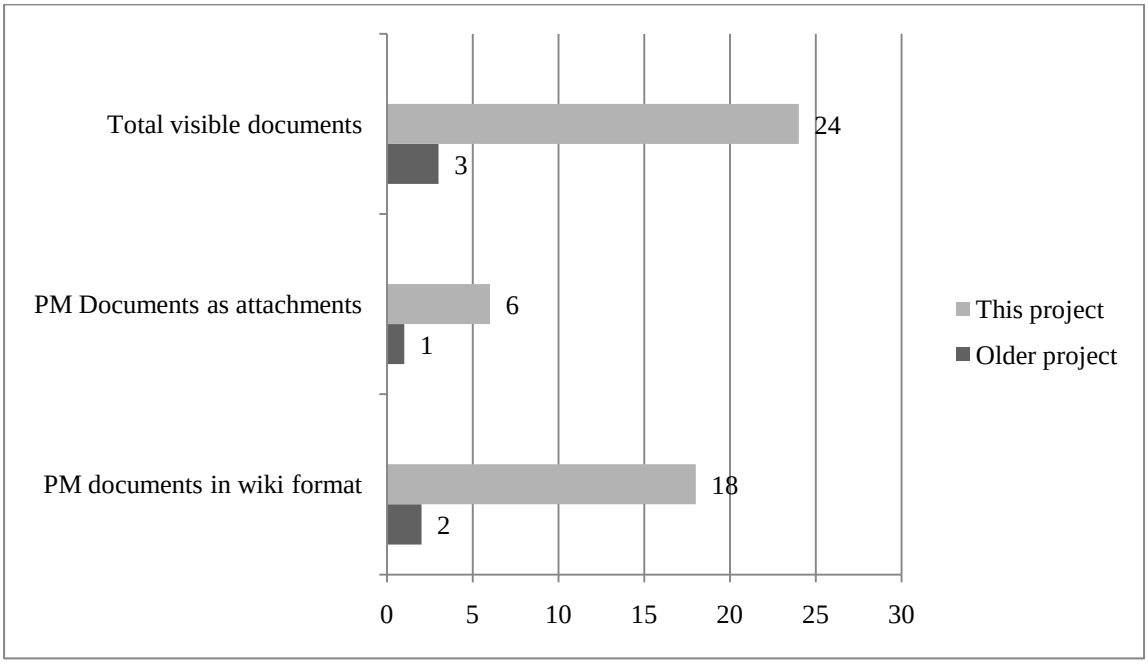


Figure 3 Chart of difference in the amount of documentation found in the wiki

The project manager also proved to be a very enthusiastic user of wikis, even though the manager had no previous experience of wiki use and was not even a programmer. The manager even advertised the virtues of the wiki way of working to other teams. This resulted in other projects also starting to use the wiki and the templates created for project documentation.

Stakeholders in the project commented that it was easy to follow the progress of the project directly from the wiki. This enabling of the logic of following lead to a reduction in e-mail traffic which meant that the project team could concentrate more on doing the actual work, increasing productivity. (Discussion 9, 2011)

Evaluation of possible compromises to the wiki way of working

The unique properties of wikis which enable the wiki way of working were identified earlier in the literature review. As in Phase 1, to ensure that these properties were not compromised as a result of the usability improvements, the effect of the improvements in Phase 2 on the properties is analyzed.

Property 1: “Everyone can easily edit, create and summarize content in a wiki without having special technical expertise”

In phase 2, the Edit Table plugin was the only special program embedded in the templates. It contained only one line of wiki markup before a table. No users reported any problems with editing pages that contained the plugin in the markup using the wiki markup editor. All users also used the plugin to edit the tables directly in the wiki interface, without using the editor, because of the convenience it offered. It should also be noted that it is expected that when a new WYSIWYG editor is installed in the future there will no longer be a need to use the Edit Table plugin. Thus this property was not negatively affected.

Property 2: “Wiki pages are stored and worked on online, reducing need for use of additional communication tools and making sure that the newest version of document is always used”.

The templates made it possible to do more work online, thus this property was positively affected.

Property 3: “Version control enables to follow up on the work progress and enables reverting of malicious or unintended edits if needed as well as enables to work on documents iteratively resulting in continuous learning."

With easier access to version control, users very able to actually utilize this functionality, and thus this property was also positively affected.

Property 4: “The wiki can be accessed from multiple locations and with multiple means, with the addresses and links pointing out to wiki pages remaining the same even if the order of the pages is reorganized.”

No changes were made regarding the access to the wiki, and thus this property was not affected.

It can be concluded that also the Phase 2 improvements had no negative effect on the unique properties of wikis, but instead had positive effects in this case.

6.5.5 Reflection and Learning

It was found that continued use of a wiki with low usability as part of work processes causes problems as very little project documentation was available on the wiki page of the previous project that the team members had participated in. Wiki had seen as being too hard to use for doing work and other tools had been used for both content creation and also for storing the documents. Unawareness of wiki functionality for those who continued to use it was also observed, particularly in not knowing about revision control or the edit table plugin, causing loss of productivity as table editing without the plugin is very time consuming. Limited benefits of wiki way of working were being experienced as wikis could not be used for collaboration in project documentation and internal transaction costs were also increased as there was no transparency in project work, and documents had to be sought for in multiple systems. Thus the original proposals about what occurs as a result of low usability of wikis were found to be true.

The proposals about what happens as a result of improving the usability were also found to be true. Improved wiki usability really to better use of wikis with a dramatic increase of 700% in the project documentation available in the wiki compared to an earlier project. Wikis were seen as a good tool for doing work with more contributors taking part in content creation, with every required project document done in the wiki. Users were also able to use advanced wiki functionality such as revision control leading to increased productivity as for example version control tables no longer had to be used. Realization of the benefits of wiki way of working, decrease in internal transaction costs as stakeholders for example no longer had to e-mail the project team members to follow the project but could see the information directly in the wiki as the work was being done.

Seeding pages with easy to edit templates were found to be a good way to increase people’s willingness to adopt the wiki way of working. It was also interesting to note that a person who

had a negative view towards wiki as a result of previous bad user experiences could be made to view the wikis positively as a result of improving the usability.

The key project data was stored as structured data, which was viewed positively as it was one of the key enablers in allowing the easy following of the project by other stakeholders, and was also received well by managers. Thus this confirms the findings in Phase 1 about the benefits of adding some structured data to the wikis with careful use of functional templates.

A wiki champion was also found in this case, which turned out to be the project manager who started to spread the word about the wiki and also suggested the most of the improvement ideas. It was interesting that unlike in Phase 1, this time the wiki champion was a person who had not used wikis before.

The documents that were posted as attachments were analyzed to find the reason why they were not made in the wiki directly. They were found to contain a lot of tables and charts. As was explained earlier, the only way to make tables easy to edit in the wiki at this stage was to put in a special code in the wiki markup, which was done for the users in the templates. However, as there were no templates for the documents that were posted as attachments, and the code to insert the edit table plugin was quite complex, so that the end users would have to spend time on learning how to use it, and adding of images also continued to be difficult, it can be concluded that the lack of a well working WYSIWYG editor was the reason why these documents were posted as attachments. The difficulty of adding tables was also confirmed by the creators of the documents as the reason why they were still created in other tools. Thus the editing toolbar was not enough to address problems with wiki editing, although those who created pages based on templates did say it was useful for them (Discussion 8, 2011).

6.6 Improvements that could not be tested because of the time limits

Further improvements in the usability of wikis were planned to be made in the near future at the case company. These included the installation of a better WYSIWYG editor. There were also plans to take a tool that allows creation of graphical charts, including project charts, easily in a

wiki. However, the implementation of those tools could not be completed in time to fit them into the scope of this thesis. Thus it could not be evaluated whether the possibility to add and edit documents easily with a WYSIWYG editor would have translated into the creation of also the documents for which templates were not available in the wiki. However, the existing research in usability regarding the positive effects of WYSIWYG editing, such as by Sinkkonen (Sinkkonen, et al., 2006) and Nielsen (Nielsen, 2001), and also the findings in this research on the behavioral changes occurring as a result of making editing easier with templates, do suggest that it could be expected. The new WYSIWYG editor was finally installed as this thesis was being finalized. The immediate feedback about the usability of the editor was very positive, suggesting that expectations about it could be realized.

Other improvements which could not be tested include improving the user interface for the tagging functionality, which at a glance seemed to need improvements. There were plans to also improve this in the future. There is also a way to create images that contain charts in the wiki itself, removing the need for many attachments, but that could also not be investigated because of time constraints. The new user interface is also planned to be taken into use for all the wiki users of the product wiki.

6.7 Formalization of Learning

In the empirical part of this thesis it was found that there were many usability issues in the wiki used in the case company. These included difficulties caused by having to use wiki markup to create content, problematic WYSIWYG editors, user tending to post documents as attachments and difficulties in discovering and using key wiki functionality caused by a badly designed interface. By comparing these problems to the findings in the literature review, it was found that all of the problems discovered in the empirical part had also been discovered earlier by other researchers. It is thus claimed that as it was possible to confirm the existence of usability problems found in earlier wiki research in the empirical part, it is wrong to assume that the wikis used today are easy to use. Even though the ease of use was one of the original wiki design principles, it does not mean that the wiki platforms are actually easy to use. The usability problems found could appear in any wiki.

Based on observations in the empirical part, the proposals in the created theoretical framework regarding the continued use of a wiki with low usability were found to be true. It was shown that continued use of a wiki with low usability as part of work processes causes problems (Proposal 1). Wiki was seen by some as being too hard to use for doing work and other tools were used to create content (P 1.1), as a lot of attachments were being posted to the wiki and there was a limited number of contributors. Those who did use the wiki were unaware of advanced wiki functionality (P 1.2) such as version control and templates. This had resulted in limited benefits of the wiki way of working and increased transaction costs (P 1.3) as information was for example not produced collaboratively and lot of time was unnecessarily spent on copy-pasting information from one place to another.

Solutions to the found usability problems were designed and implemented in the empirical part. Two design principles, based on findings in usability research, were used as a basis for designing the usability improvements to the wiki. The first principle was that it should be easy to edit, create and discover information. Ease of editing and creating information means that modifying the stored information in the system should be easy and the effort required to create new information should be as minimal as possible. Ease of discovering information, on the other

hand, means producing information in a way that makes it easy for the end users to find it. The second design principle was that the key features of the information system should be easy to find and use. This principle relates to user interface design. It means that end users should easily recognize the functionality offered by the information system and once they recognize the functionality, they should also be able to use it.

The two design principles used can be generalized and applied to other information systems than only the wiki. The first design principle can be used in all the information systems that end users can use to create information such as word processors and database applications. The second principle can be used in all information systems that offer the end users a user interface that can be used to access functions.

Two different means were used to improve the usability of the wiki. The first was utilizing templates. In many information systems, new information can be based on ready-made creational templates that contain information that the users can freely modify. This makes it easier to create information, which was a part of the first design principle. In phase 1 of the empirical part, the creational templates were designed based on repetitive behavior found to be occurring in the wiki pages created by the users. All the information that was repeated on the existing pages was included in the templates, so that the users did not have to unnecessarily produce the information again. Creational templates were also used in phase 2, but they were designed differently. It was learned that there were existing templates in other information systems (word processors and spreadsheet calculators) that would make it easier to create project documentation, which was the objective of the team observed in phase 2. These templates were converted to wiki format. In addition, the links to the templates were placed on a newly created project page template so that they were easy to find, both by project team members and other stakeholders. This followed the design principle of making it easier to discover information.

Creational templates can also contain additional functionality. It was found that editing tables was very difficult in the wiki, and that there was a way to include a plugin that made table editing easier to the templates. All of the tables in the templates were made easier to edit in both phase 1

and 2. This suited the “easy to modify” criteria set in the first design principle. In addition, some other functionality such as statistics calculation was embedded in the templates in phase 1.

It was learned that users found that the creational templates were helpful in their daily working tasks. The templates were also improved based on the users’ requests. Based on user feedback, the ease of creating and modifying content that the templates enabled was a key factor in increasing the wiki contribution rate in phase 1 from 17% to over 80%. In phase 2, it was learned that the lack of templates in the wiki was one of the key reasons why wiki had not been used for project documentation. In an earlier project, only two project management documents were done in the wiki whereas in the observed project all the 18 documents were actually created in the wiki because of the templates that could be accessed easily.

Creational templates that contain information can also be used in many other information systems such as word processors and spreadsheet calculators. The two different principles used in finding the information to be included to the templates, observing existing behavior to create new templates and converting the templates from the file format of one system to another, can also be applied in template creation in other information systems. Placing advanced functionality to the templates is also possible in some information systems, such as spreadsheet calculators where formulas can be placed in templates so that users do not have to know how to write them. The logic of the advanced functionality can also either be converted from the functionality of other information systems or created based on found repetitive activity. As stated earlier, all these methods were found to be helpful in improving usability and that should apply to other information systems as well.

Functional templates were also used in addition to creational templates in both phases of the empirical part. They can be used to store structured data that can be shown on multiple pages and can be easily restructured. The main difference to creational templates is that the data labels cannot be modified by end users when the data is entered, but they can be altered collectively for all the pages based on the template. Some key figures were stored in the functional templates, such as project status. It was found that the stakeholders searching the wiki for information found the functional templates useful as they could use them to quickly see the key information, thus

following the design principle of making information easier to discover. However, it was not seen as a major factor in getting users to contribute more. Functional templates can also be used in some other information systems, such as database applications.

In addition to utilizing templates, major user interface improvements were also done. A new user interface for the wikis was implemented in phase 2 of the empirical part. The new interface had originally been designed by usability experts for the case company. It was found that the new interface followed basic usability rules set out by usability experts. Key features such as search and basic wiki functions were placed so that users could locate them easily. This interface was also similar to other information systems used in the company, thus reducing the users' learning curve. The researcher also made some functions, such as the revision control feature, easier for the end users to recognize by adding a clarification text. This was recommended in usability research for new functionality that users might not be aware of. Also vocabulary used to describe functions was altered to be similar to other tools, such as changing the naming of the function "checkpoint" to "save" so that users would not have to unnecessarily learn new terminology. All of these improvements followed the design principle "key system features should be easy to find and use". Based on user feedback, the users who had not previously used the wiki found the wiki interface easy to use. Those who were already familiar with the wiki could still use some features, such as revision control, for the first time because of the new interface as they had not been able to recognize that functionality in the earlier wiki interface.

An attempt was also made to make editing easier by using wiki markup, because a WYSIWYG editor could not be installed in time. Based on suggestions in research a wizard was created by adding a toolbar to the editor. The toolbar contained easy to recognize icons, similar to word processors that could be used to add formatting commands such as "bold" or "italic" within text without having to remember the command. The users did find this to be helpful, although based on findings a well functioning WYSWIYG was still needed. It was installed as the thesis was being finalized, but could not be observed.

The principles used to design the interface improvements made can also be used in other information systems. The elements of the user interface should be placed so that they are easy to

find and recognize, as well as easy to use. It is also beneficial to use similar vocabulary for similar functions and to have a similar, well designed, user interface in different information systems to reduce the users' learning curve. All of these improvements should increase usability of any information system. The editing toolbar can also be used in other information systems that are used to create content that is formatted with formatting commands, especially if there is no possibility to use a WYSIWYG editor. However, based on multiple findings in usability research, a WYSIWYG editor is still recommended for all content creation systems, although some experienced users might still prefer using the markup.

Based on what was learned in this research it can be claimed that attention should be paid to solving usability problems experienced by the users of information systems they use in their daily working life. It is also possible to see improvements quickly. This is also similar to findings in information system usability research in general. (Donahue, et al., 1999). The basic design principles used in this research are generic and the methods used to improve usability, templates and user interface improvements, can be applied to many other information systems as well. It was also learned that even when there are a lot of problems in the usability of an information system, it is possible to improve usability iteratively. It was shown that greatly improved results can be achieved even by only fixing some of the problems.

As the improvements were found to be successful, it was also possible to test the validity of the proposals of the created framework about the effects that improving the usability of a wiki would have. It was found that improved wiki usability leads to better use of wikis (Proposal 2). Wikis were being seen as a good tool for doing work with more contributors taking part in content creation (P 2.1). Contribution rate increased dramatically in phase 1 and there was a huge improvement in amount of documentation created in the wiki in phase 2. Users were also able to use advanced wiki functionality, such as version control, leading to increased productivity (P 2.2), This lead to realization of the benefits of wiki way of working and a decrease in internal transaction costs (P 2.3) as the wiki for example helped automate manual tasks and stakeholders could follow work transparently without sending e-mails. Without further research it cannot be validated whether at least some of these proposals could apply to improving the usability of other

content creation tools as well. It can still be speculated that for example the contribution rate of users using a hard-to-use content creation tool could be increased by improving its usability.

Getting back to the original research question, it was learned that the willingness of employees to adopt the wiki way of working can be increased by improving the usability of an existing wiki. It was also found that the usability of a wiki can also be improved without sacrificing the unique technical properties of the wiki, which can be summarized as possibility for everyone to edit anything, working on the pages iteratively online, version control and easy access to the wiki.

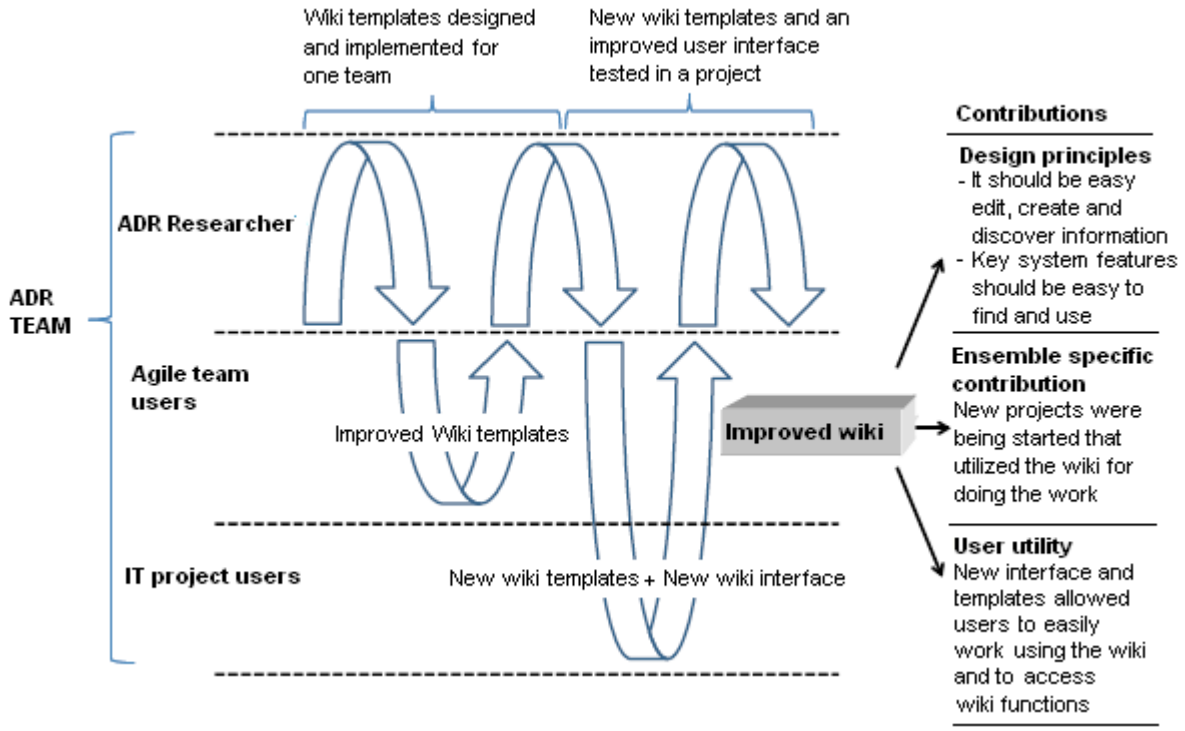


Figure 4: Summary of the actions taken in the empirical part

Design Principle	**Means used**	**Generalization**
It should be easy to edit, create and discover information	Creational templates, created by converting existing ones and making new ones based on found repetitive behavior	Can be used in Information Systems where content is produced
	Using functional templates to make information easier to discover	Can be used in Information Systems where content is produced
	Adding advanced functionality to templates to make specific tasks easier	Can be used in some Information Systems such as spreadsheet calculators
Key system features should be easy to find and use	New interface that is based on generic usability research findings	Can be used in almost all Information Systems
	Vocabulary used to describe functions made similar to other tools	Can be used in almost all Information Systems
	A toolbar was added to help creating markup	Can be used in systems that have no WYSIWYG editor to format content

Table 3: Summary of design principles used and applied in the empirical part and how they can be generalized

7. CONCLUSION

7.1 Summary

Wikis have some unique properties that make them an innovative IT tool for organizations. Many of them are linked to the special properties of Enterprise 2.0 tools. It was found that the four key issues that enable the wiki way of working are:

1. Everyone can edit anything easily
2. Documents are worked on iteratively online with the most recent version always available to everyone
3. Version control allows for example tracking of progress and iterative content creation
4. It is easy to access the wiki from multiple locations and with different means, including linking wiki pages to one another

The wikis can be used for various tasks and in many different types of organizations. Implementation issues regarding for example management support for openness of the wiki way of working can appear, but those can be overcome.

While many researchers continue to insist that wikis are designed to be easy to use, and thus are an easy tool for everyone, there are many problems regarding the usability of wikis. All wikis are not easy to use, even though ease of use was one of the original design principles. It was however found that there are also many methods that can make wikis easier for everyone to use.

Based on findings in the literature review, a theoretical framework was created about the issues caused by continuing to use a wiki with usability problems. All the proposals in formed the framework were found to be true in empirical research done at a case company were the usability of a wiki was first analyzed and was found to be low. Continued use of a wiki with low usability as part of work processes had caused problems (Proposal 1). Wikis were seen by some as being too hard to use for doing work and other tools were being used for content creation (P 1.1), with lots of attachments made using other tools posted to the wiki. Unawareness of wiki functionality for those who continued to use it was found (P 1.2) such as revision control. Lack of knowledge

about even basic wiki features lead to limited benefits of wiki way of working, leading to increased transactional costs (P 1.3), such as having to manual calculations.

Usability of the wiki was improved and the effect of the improvements on wiki use was followed. Two basic design principles were used in designing the improvements. The first was that it should be easy to edit, create and discover information and the second that key system features should be easy to find and use. These principles can also be used in many other information systems. Two methods were used to improve usability. The first was creating new templates and converting existing ones to the wiki. This method can be used in most information systems that are used to produce content, such as word processor. The interface of the wiki was also improved by modifying the interface so that key functions were easy to find, recognize and use. These improvements can be done in almost every information system that has a user interface.

Another framework was formed about what would happen if the usability of an existing wiki was improved, based on findings in literature review. The proposals in that framework were also found to be true. It was shown that improved wiki usability lead to better use of wikis (Proposal 2). Wikis were seen as a good tool for doing work with more contributors taking part in content creation (P 2.1) as significant contribution rate increases were observed. Users were able to use advanced wiki functionality leading to increased productivity (P 2.2) such as revision control. The benefits of wiki way of working were realized with users being able to work using the wiki leading to a decrease in internal transaction costs (P 2.3) as stakeholders were able to follow work progress from the wiki instead of using other communication tools. It is possible that some of these proposals are true for other content creation as well.

To conclude, it was learned that the willingness of employees to adopt the wiki way of working can be increased by improving the usability of an existing wiki. It was also found that the usability of a wiki can be improved without sacrificing the unique technical properties of the wiki.

7.2 Suggestions for future research

To validate the framework used, it should also be tested in other case companies and also possibly using different tools. It would also be interesting to return to the department of this case company where this research was being conducted in the future to evaluate if the improvements made during this study have had a long term impact. It would especially be beneficial to investigate what effect a new WYSIWYG editor which was installed just as this thesis was being finalized had on the use of wikis.

While semantic wikis seem a promising technology, the wiki syntax used in them is more complex than in basic wikis. This means that the usability problems in semantic wikis are likely to be more difficult to tackle. Still, some usability research could be made regarding their use, as there are already some WYSIWYG editors available for semantic wikis that aim to make them easier to use, such as in Ontoprise (Ontoprise, 2011).

Another interesting research question would be to look at wikis – or another system with known usability problems – from the perspective that why isn't there more attention paid to usability issues in IT systems. In this thesis, it was not very difficult to fix some serious usability concerns, but for some reason they had not been tackled before. As improving the usability of an IT system can improve the productivity of employees using it, it would be relevant to pay more attention to the reasons why it is sometimes ignored.

8. WORKS CITED

Agarwal, Ritu and Prasad, Jayesh. 1998. A Conceptual and Operational Definition of Personal Innovativeness in the Domain of Information Technology. *Information Systems Research.* 1998, Vol. 9, 2.

AIIM. 2008. *AIIM Market IQ. Enterprise 2.0: agile, emergent and integrated.* 2008.

Al-Asmari, Khalid Rames and Yu, Liguo. 2007. *Experiences in Distributed Software Development with Wiki.* WikiSym '07 Proceedings of the 2007 international symposium on Wikis : ACM, 2007.

Ames, Morgan and Mor, Naaman. 2007. *Why we tag: motivations for annotation in mobile and online media.* Proceedings of the SIGCHI conference on Human factors in computing systems : s.n., 2007.

Andersson, Erik, Rosenström, Per and Söhrman, Sebastian. 2007. *Introducing the wiki concept to a knowledge organisation.* GÖTEBORG : IT UNIVERSITY OF GÖTEBORG, 2007.

Anslow, Craig and Riehle, Dirk. 2007. *Lightweight End-User Programming with Wikis.* Software Engineering Workshop at WikiSym 2007 : SAP Research, 2007.

Arazy, O, et al. 2009. Wiki deployment in corporate settings. *IEEE TECHNOLOGY AND SOCIETY MAGAZINE.* 2009, SUMMER 2009.

Atlassian. 2010. [Online] 2010. [Cited: November 16, 2010.] http://www.atlassian.com/software/confluence/.

Au Yeung, C. M., Gibbins, N and Shadbolt, N. 2007. *Tag Meaning Disambiguation through Analysis of Tripartite Structure of Folksonomies.* ACM International Conferences on Web Intelligence and Intelligent Agent Technology : s.n., 2007.

Baggs, Judith and Schmitt, Madeline H. 2007. *Collaboration between nurses and physicians.* s.l. : Journal of Nursing Scholarship, 2007.

Bairstow, Jeffrey. 2003. Is there a 'wiki' in your future? *Laser Focus World.* [Online] July 1, 2003. [Cited: March 06, 2011.] http://www.optoiq.com/index/photonics-technologies-applications/lfw-display/lfw-article-display.articles.laser-focus-world.volume-39.issue-7.departments.in-my-view.is-there-a-wiki-in-your-future.html.

Bean, L and Hott, D.D. 2005. Wiki: A Speedy New Tool to Manage Projects. *Journal of Corporate Accounting & Finance.* 2005, Vol. 16, 5.

Ben-Chaim, Yochai, Farchi, Eitan and Raz, Orna. 2009. *An effective method for keeping design artifacts up-to-date.* Vancouver : IEEE, 2009. 978-1-4244-3742-9.

Benjamin, Cowan, Lorenzo, Vigentini and Jack, Mervyn A. 2009. *Exploring the effects of experience on wiki anxiety and wiki usability: an online study.* s.l. : British Computer Society, 2009.

Buffa, Michael. 2006. *Intranet wikis.* s.l. : University of Nice, 2006.

C., Wagner. 2004. Wiki: A Technology for Conversational Knowledge Management and Group Collaboration. *Communications of the Association for Information Systems.* 2004, Vol. 13.

Chao, Joseph. 2007. *Student project collaboration using Wikis.* s.l. : Bowling Green State University, 2007.

Chau, Thomas and Maurer, Frank. 2005. *A case study of wiki-based experience repository at a medium-sized software company.* s.l. : University of Calgary, 2005.

Cheung, K. S. K., et al. 2005. The Development of Successful On-Line Communities. *International Journal of The Computer, the Internet and Management.* 2005, Vol. 13#1.

Cooney, Laura. 2006. *Wiki as a Knowledge Management Tool.* s.l. : CERAM Sophia-Antipolis, 2006.
Cowan, Benjamin R, Vigentini, Lorenzo and Jack, Mervyn A. 2009. *EXPLORING THE EFFECTS OF EXPERIENCE ON WIKI ANXIETY AND WIKI USABILITY: AN ONLINE STUDY.* Swinton : British Computer Society, 2009.
Cowan, Benjamin R., et al. 2008. *EXPLORING THE RELATIONSHIP BETWEEN ANXIETY AND USABILITY EVALUATION - AN ONLINE STUDY OF INTERNET AND WIKI ANXIETY.* Amsterdam : s.n., 2008.
Cunningham, W and Leuf, B. 2001. *The Wiki Way: Quick Collaboration on the Web.* s.l. : Addison-Wesley, 2001.
Da Lio, Elizabeth, Fraboni, Lucia and Leo, Tommaso. 2005. *TWiki-based facilitation in a newly formed academic community of practice.* San Diego : ACM, 2005. 1-59593-111-2/05/0010.
Danis, Catalina and Singer, David. 2008. *A Wiki Instance in the Enterprise: Opportunities, Concerns and Reality.* San Diego : ACM, 2008.
Daum, Michael. 2008. TWiki Applications. *TWiki.* [Online] June 11, 2008. [Cited: November 16, 2010.] http://TWiki.org/cgi-bin/view/Codev/TWikiApplication.
Davis, Fred D. 1989. Perceived usefulness, perceived ease of use, and user acceptance of information technology. *MIS Quarterly.* 1989, Vol. 13(3).
Decker, Björn, et al. 2005. *A Framework for Agile Reuse in Software Engineering using Wiki Technology.* s.l. : Fraunhofer, 2005.
Decker, Björn, et al. 2007. Wiki-Based Stakeholder Participation in Requirements Engineering. *IEEE SOFTWARE.* 2007, Marc h / April.
Decker, et al. 2005. *Self-organized Reuse of Software Engineering Knowledge Supported by Semantic Wiki.* Workshop on Semantic Web Enabled Software Engineering : s.n., 2005.
DeLone, W.H and McLean, E.R. 2003. The DeLone and McLean Model of Information Systems Success: A Ten-Year Update. *Journal of Management Information Systems* . (19:4), Spring, 2003.
Desilets, A, Paquet, S and Vinson, N. 2005. *Are wikis usable?* s.l. : NRC Publications, 2005.
Di Iorio, Angelo, Vitali, Fabio and Zacchiroli, Stefano. 2007. *Templating Wiki Content for Fun and Profit.* s.l. : University of Bologna, 2007.
Dickerson, Chad. 2004. Is Wiki under your radar. *Infoworld.* 2004, November 05, 2004.
Dickerson, Chad. 2004. Wiki goes to work. *Infoworld.* 2004, Vol. November 12.
Discussion. 2010. Discussion between manager and researcher. *December 7th.* 2010.
—. 2011. Discussion between project team members and the author. *January 28th.* 2011.
—. 2011. Discussion between researcher and user. *March 4th.* 2011.
—. 2010. Discussion with Former Senior Manager. *July 6th.* 2010.
—. 2011. Discussion with PM and manager. *January 26th.* 2011.
—. 2010. Discussion with PM and SM. *December 14th.* 2010.
—. 2010. Discussion with two Line Managers. *September 15th.* 2010.
—. 2011. Discussion with two Managers. *January 18th.* 2011.
—. 2010. Discussion with two senior managers. *October 11th.* 2010.
—. 2010. Discussion with with SM. *December 14th.* 2010.
Donahue, George M., Nowicki, Julie and Weinschenk, Susan. 1999. *Usability Is Good Business.* s.l. : Compuware, 1999.
Drucker, Peter F. 1998. Management's New Paradigms. *Forbes.* 1998, 10.05.

Dyer, Lisa and Gentle, Anne. 2008. *Using Structured Wikis in Software Engineering.* 2008.
Edwards, Penny. 2007. *Managing Wikis in Business.* Milton Keynes : Open University Business School, 2007.
Farrell, Robert G., Kellogg, Wendy A. and Thomas, John C. 2008. *The Participatory Web and the Socially Resilient Enterprise.* s.l. : IBM T.J. Watson Research Center, 2008.
Ferreira, David de Almeida and da Silva, Alberto Rodrigues. 2009. *An EnhancedWiki for Requirements Engineering.* 35th Euromicro Conference on Software Engineering and Advanced Applications : s.n., 2009.
Fokaefs, Marios, Bauer, Ken and Stroulia, Eleni. 2009. *WikiDev 2.0: Web-based Software Team Collaboration.* s.l. : 2009 WIKIS4SE 09 ICSE Workshop on DOI , 2009.
Frappaolo and Keldsen. 2008. *Enterprise 2.0: agile emergent and integrated. .* s.l. : AIIM Market IQ, 2008.
Fuchs-Kittowski, F. and Kohler, A. 2005. *Wiki Communities in the Context of Work Processes.* San Dieg : ACM, 2005.
Gaofeng, Zhang, Zhiyi, Qu and Adi, Guo. 2008. *Using Folksonomies to Improve Peer-to-Peer Knowledge Sharing.* Moscow : IEEE, 2008.
Gartner. 2009. *Hype Cycle for Social Software.* 2009.
Gholami, Behnaz and Safavi, Roshanak. 2010. *Harnessing Collective Intelligence Wiki and Social Network from End-user Perspective.* International Conference on e-Education, e-Business, e-Management and e-Learning : s.n., 2010.
Gonzalez-Reinhart, Jennifer. 2005. *Wiki and the Wiki Way: Beyond a Knowledge Management Solution.* s.l. : University of Houston, 2005.
Grudin, Jonathan and Poole, Erika Shehan. 2010. *Wikis at Work: Success Factors and Challenges for Sustainability of Enterprise Wikis.* Gdarisk : s.n., 2010.
Gutman, Scott. 2010. TWiki. *Comment Plugin.* [Online] October 12, 2010. [Cited: November 16, 2010.] http://TWiki.org/cgi-bin/view/Plugins/CommentPlugin.
Haake, Anja, Lukosch, Stephan and Schümmer, Till. 2005. *Wiki Templates.* San Diego : ACM, 2005. 1-59593-111-2/05/0010.
Halvey and Keane. 2007. *An Assessment of Tag Presentation Techniques.* WWW '07 Proceedings of the 16th international conference on World Wide Web : s.n., 2007.
Happel, Hans-Jörg and Treitz, Marius. 2008. *Proliferation in Enterprise Wikis.* Proceedings of the 8th International Conference on the. Design of Cooperative Systems (COOP 08) : s.n., 2008.
Hasan, H and Pfay, C. 2006. *Emergent Conversational Technologies that are Democratising Information Systems in Organisations. The case of the corporate wiki.* Canberra : s.n., 2006.
Hasan, Helen and Pfaff, Charmaine C. 2006. *The Wiki: an environment to revolutionise employees' interaction with corporate knowledge.* OZCHI 2006 Proceedings : s.n., 2006. 1-59593-545-2.
Hasan, Helen and Pfaff, Charmaine C. 2006. *Overcoming Organisational Resistance to Using Wiki Technology for Knowledge Management.* PACIS 2006 Proceedings : Association for Information Systems, 2006.
Hayman. 2007. *FOLKSONOMIES AND TAGGING: New developments in social bookmarking.* Proceedings of the Ark Group Conference: Developing and Improving Classification Schemes : s.n., 2007.
Henriksson, Jani and Mikkonen, Teemu. 2008. *Wiki-kokemuksia suomalaisissa organisaatioissa.* Tampere : Tampere University Press, 2008.

Hester, Andrea J and Scott, Judy E. 2008. *A Conceptual Model of Wiki Technology Diffusion.* 41st Hawaii International Conference on System Sciences : s.n., 2008.
Hester, Andrea J. 2010. *Increasing Collaborative Knowledge Management in Your Organization: Characteristics of Wiki Technology and Wiki Users.* s.l. : Southern Illinois University Edwardsville, 2010.
Hilska-Keinänen, Katja. 2009. Wiki as an Intranet. *Journal of EAHIL.* 2009, Vol. 5, 2.
Hinchcliffe, Dion. 2009. 14 Reasons Why Enterprise 2.0 Projects Fail. *Enterprise Web 2.0.* [Online] ZDNet, August 21, 2009. [Cited: November 18, 2010.] http://www.zdnet.com/blog/hinchcliffe/14-reasons-why-enterprise-20-projects-fail/718.
Holtzblatt, Lester J., Damianos, Laurie E. and Weiss, Daniel. 2010. *Factors impeding Wiki use in the enterprise: a case study.* Atlanta, Georgia, USA. : s.n., 2010.
Honegger, Beat Doebeli. 2005. *Wikis – a Rapidly Growing Phenomenon in the German-Speaking School Community.* WikiSym '05 : s.n., 2005.
ISO 9241-11. 1998. ISO 9241. Guidance on usability. *Wikipedia.* [Online] 1998. [Cited: November 4th, 2010.] http://en.wikipedia.org/wiki/ISO_9241#ISO_9241-11.
Jesdanun, Anick. 2004. What's a wiki? It's all about sharing. *The Seattle Times.* 2004, September 27.
Jing, Huang and Fan, Yang. 2008. *Usability of Wiki for Knowledge Management of Knowledge-Based Enterprises.* International Symposium on Knowledge Acquisition and Modeling : s.n., 2008.
Kakali and Papatheodorou. 2010. Exploitation of folksonomies in subject analysis. *Library & Information Science Research.* 2010, Vol. 32, 2.
Kenney, Brad. 2008. Seven Strategies for Implementing a Successful Corporate Wiki. *Industryweek.* 2008, Jan. 25.
Kickmeier-Rust, Michael, Ebner, Martin and Holzinger, Andreas. 2006. *Wikis: Do they need usability engineering?* the 2nd Symposium WG HCI&UE, Österreichische Computergesellschaft, Wien : s.n., 2006.
Kilpi, Esko. 2006. The Power of Peer Production. *Nokia People.* 2006, 7.
Krötzsch, et al. 2006. *Semantic Wikipedia.* Proceedings of the 15th international conference on World Wide Web : s.n., 2006.
Lanubile, Filippo. 2009. *Collaboration in Distributed Software Development.* Bari : University of Bari, 2009.
Liang, Michale, et al. 2009. *COMPARING USER EXPERIENCES IN USING TWIKI & MEDIAWIKI TO FACILITATE COLLABORATIVE LEARNING. MICHAEL LIANG, SAM CHU, FELIX SIU and AUDREY ZHOU.* Proceedings of the 2009 International Conference on Knowledge Management. Hong Kong : s.n., 2009.
Lih, Andrew. 2009. *The Wikipedia Revolution: How a Bunch of Nobodies Created the World's Greatest Encyclopedia.* s.l. : Hyperion, 2009.
Louridas, Panagiotis. 2006. Using Wikis in Software Development. *IEEE SOFTWARE.* 2006, March/Apriil.
Majchrzak, Ann, Wagner, Christian and Yates, Dave. 2006. *Corporate wiki users results of a survey.* WikiSym'06 Odense, Denmark. : s.n., 2006.
—. 2006. *The role of shapers in virtual firm-based practice networks.* s.l. : under review at Management Science, 2006.
Manager, Product. 2011. Product objective fullfilment at Case Company. 2011.

McAfee, Andrew P. 2006. Enterprise 2.0 The Dawn of Emergent Collaboration. *WikiSym'06, August 21–23, 2006, Odense, Denmark.* 2006, Spring.
McKinsey. 2009. *Global Survey Results: How companies are benefiting from Web 2.0.* 2009.
Mican and Tomai. 2010. *Web 2.0 And Collaborative Tagging.* Fifth International Conference on Internet and Web Applications and Services (ICIW) : s.n., 2010.
Millen and Feinberg. 2006. *Using Social Tagging to Improve Social Navigation.* s.l. : IBM T. J Watson Research Center., 2006.
Möller, Claudia and Birn, Lukas. 2006. *Wikis for Collaborative Software Documentation.* Proceedings of I-KNOW '06 Graz, Austria : s.n., 2006.
Moore, Richard, et al. 2007. *Scrum at a Fortune 500 Manufacturing Company.* AGILE 2007 conference Washington, D.C. : s.n., 2007.
Munson, Sean A. 2008. *Motivating and enabling organizational memory with a workgroup wiki.* WikiSym '08, Porto, Portugal. : s.n., 2008.
Nichols, David M and Twidale, Michael B. 2003. The usability of open source software. *First Monday.* 2003, Vol. 8, 1-6.
Nielsen, Jakob. 2001. *Designing Web Usability.* Indiana : New Riders Publishing, 2001.
—. 1994. Heuristic evaluation. [book auth.] Jakob Nielsen and Robert L. Mack. *Usability Inspection Methods.* s.l. : John Wiley & Sons, 1994.
—. 2009. How Aggressively to Redesign. *Jakob Nielsen's Alertbox.* [Online] September 21, 2009. [Cited: March 3, 2011.] http://www.useit.com/alertbox/familiar-design.html.
Ontoprise. 2011. Semantic Enterprise Wiki. *Ontoprise.* [Online] 2011. [Cited: March 6, 2011.] http://www.ontoprise.de/en/solutions/smw-plus/.
Pastorelli, Rossella. 2009. TWiki Forms . *TWiki.* [Online] November 03, 2009. [Cited: November 22, 2010.] http://TWiki.org/cgi-bin/view/TWiki/TWikiForms.
Pfaff, Helen Hasan & Charmaine C. 2006. *The Wiki: an environment to revolutionise employees' interaction with corporate knowledge.* OZCHI 2006, November 20-24, 2006, Sydney, Australia : s.n., 2006.
Phuwanartnurak, Ammy Jiranida. 2009. *Did you put it on the wiki?: information sharing through wikis in interdisciplinary design collaboration.* SIGDOC'09, October 5–7, 2009, Bloomington, Indiana, : s.n., 2009.
Quan, Lu, Yu-ying, Jiao and Jing, Chen. 2008. *UIMwiki: An Enhanced Semantic Wiki for User Information Management.* IEEE International Symposium on IT in Medicine and Education : IEEE, 2008.
Radziwill, Nicole M and Shelton, Amy L. 2004. *TWiki as a Platform for Collaborative Software Development Management.* s.l. : National Radio Astronomy Observatory, 2004.
Russell, Terrell. 2006. *Cloudalicious: Folksonomy Over Time.* JCDL '06 Proceedings of the 6th ACM/IEEE-CS joint conference on Digital libraries : ACM, 2006.
SAP. 2010. SAP Community Network. *SAP.* [Online] June 30, 2010. [Cited: November 23, 2010.] http://wiki.sdn.sap.com/wiki/display/WHP/Home.
Sauer, Christoph, et al. 2007. *WikiCreole: A Common Wiki Markup.* WikiSym'07 Montréal, Québec, Canada : s.n., 2007.
Schaffert, Gruber and Westenthaler. 2005. *A SEMANTIC WIKI FOR COLLABORATIVE KNOWLEDGE FORMATION.* Salzburg : Salzburg Research, 2005.
Schaffert, Sebastian, et al. 2008. Semantic Wikis. *IEEE Software.* 2008, Vol. 25, 4.
Sein, Maung K, et al. 2011. Action Design Research. *MIS Quarterly.* 2011, Vol. 35, 2.
Sinkkonen, Irmeli, et al. 2006. *Psychology of usability.* s.l. : IT Press, 2006.

Socialtext. 2010. Socialtext. [Online] 2010. [Cited: November 16, 2010.] http://www.socialtext.com/.
Stocker, Alexander and Tochtermann, Klaus. 2009. *EXPLORING THE VALUE OF ENTERPRISE WIKIS.* s.l. : Austrian COMET Program, 2009.
Sturtz, David N. 2004. *Communal Categorization: The Folksonomy.* s.l. : Drexel University, 2004.
Stvilia, Besiki, et al. 2007. *Information Quality Work Organization in Wikipedia.* s.l. : JASIST, 2007.
Subramaniam, Venkat and Hunt, Andy. 2006. *Practices of an Agile Developer Working in the Real World.* s.l. : The Pragmatic Programmers, LLC, 2006.
SUN, CHENGZHENG, et al. 2006. *Transparent Adaptation of Single-User Applications for Multi-User Real-Time Collaboration.* ACM CSCW conference : s.n., 2006.
Tapscott, Don. 2006. *Winning with the Enterprise 2.0* . s.l. : New Paradigm Learning Corporation, 2006.
Thoeny, Peter. 2010. Search Pattern Cookbook. *TWiki.* [Online] April 28, 2010. [Cited: November 29, 2010.] http://TWiki.org/cgi-bin/view/TWiki/SearchPatternCookbook.
—. 2010. Template Topics in Action. *TWiki.* [Online] September 20, 2010. [Cited: November 30, 2010.] http://TWiki.org/cgi-bin/view/TWiki/TWikiTemplates#Template_Topics_in_Action.
—. 2010. TWiki. *TWiki Spreadsheet Plugin* . [Online] August 27, 2010. [Cited: November 16, 2010.] http://TWiki.org/cgi-bin/view/Plugins/SpreadSheetPlugin.
—. 2010. TWiki. *TWiki Extensions Repository* . [Online] January 3, 2010. [Cited: November 16, 2010.] http://TWiki.org/cgi-bin/view/Plugins/.
—. 2010. TWiki - the Open Source Enterprise Wiki and Web 2.0 Application Platform. *TWiki.* [Online] November 1, 2010. [Cited: November 16, 2010.]
—. 2009. TWiki Skin Packages. *TWiki.* [Online] December 23, 2009. [Cited: November 17, 2010.] http://TWiki.org/cgi-bin/view/Plugins/SkinPackage.
—. 2010. TWiki Skins . *TWiki.* [Online] May 30, 2010. [Cited: November 17, 2009.] http://TWiki.org/cgi-bin/view/TWiki/TWikiSkins.
—. 2010. TWiki Templates. *TWiki.* [Online] September 20, 2010. [Cited: November 22, 2010.] http://TWiki.org/cgi-bin/view/TWiki/TWikiTemplates#Specifying_a_Form.
Trkman, Marina and Trkman, Peter. 2008. A wiki as intranet: a critical analysis using the Delone and McLean model. *Online Information Review.* 2008, Vol. 33, 6.
VanDeursen and Visser. 2002. *The Reengineering Wiki.* s.l. : Utrecht University, 2002.
Venkateswaran, R. 2001. Virtual private networks. *Potentials, IEEE* . 2001, Vol. 20, 1.
Wagner, C. 2004. *Wiki: A Technology for Conversational Knowledge Management and Group Collaboration.* 2004.
Wagner, Christian and Majchrzak, Ann. 2007. Enabling Customer-Centricity Using Wikis and the Wiki Way. *Journal of Management Information Systems.* Winter 2006–7, 2007, Vol. 23, 3.
Wei, Carolyn, et al. 2005. *Wikis for Supporting Distributed Collaborative Writing.* s.l. : STC, 2005.
White, Kevin F, Lutters and G., Wayne. 2007. *Midweight Collaborative Remembering: Wikis in the Workplace.* CHIMIT'07, March 30-31, 2007, Cambridge, MA, U.S.A. : s.n., 2007.
Wikimedia. 2009. Category:All Extensions. [Online] September 18, 2009. [Cited: November 16, 2010.] http://www.mediawiki.org/wiki/Category:All_extensions.

—. 2010. How does Mediawiki work. *Mediawiki.* [Online] June 13, 2010. [Cited: November 16, 2010.] http://www.mediawiki.org/wiki/How_does_MediaWiki_work%3F.
Wikimedia Usability Initiative Team. 2010. Usability and Experience Study. *Wikimedia usability initiative.* [Online] August 23, 2010. [Cited: November 29, 2010.] http://usability.wikimedia.org/wiki/Usability_and_Experience_Study.
Wikimedia Usability Initiative. 2010. Usability, Experience, and Evaluation Study. *Wikimedia Usability Initiative.* [Online] November 23, 2010. [Cited: November 29, 2010.] http://usability.wikimedia.org/wiki/Usability,_Experience,_and_Evaluation_Study.
Wu., DY Di. 2010. *Finding Success in Rapid Collaborative Requirements Negotiation Using Wiki and Shaper.* Proceedings of the 43rd Hawaii International Conference on System Sciences : s.n., 2010.
Yang, Da, et al. 2008. *WikiWinWin: A Wiki Based System for Collaborative Requirements Negotiation.* Proceedings of the 41st Hawaii International Conference on System Sciences : s.n., 2008.
Yochai, Ben-Chaim, Farchi, Eitan and Raz, Orna. 2009. *An effective method for keeping design artifacts up-to-date.* Wikis4SE'09, Vancouver, Canada : s.n., 2009.

9. APPENDICES

9.1 Appendix 1

An example of a table being edited using wiki markup

```
| Table heading | Table Heading | Table Heading | Table Heading | Table heading | Table heading |
| First cell of a table | Second cell of a table | Third cell of a table| Fourth cell of a table
| Fifth cell of table | Sixth cell of a table |
| First cell of a table | Second cell of a table | Third cell of a table| Fourth cell of a table
| Fifth cell of table | Sixth cell of a table |
| First cell of a table | Second cell of a table | Third cell of a table| Fourth cell of a table
| Fifth cell of table | Sixth cell of a table |
| First cell of a table | Second cell of a table | Third cell of a table| Fourth cell of a table
| Fifth cell of table | Sixth cell of a table |
| First cell of a table | Second cell of a table | Third cell of a table| Fourth cell of a table
| Fifth cell of table | Sixth cell of a table |
| First cell of a table | Second cell of a table | Third cell of a table| Fourth cell of a table
| Fifth cell of table | Sixth cell of a table |
| First cell of a table | Second cell of a table | Third cell of a table| Fourth cell of a table
| Fifth cell of table | Sixth cell of a table |
| First cell of a table | Second cell of a table | Third cell of a table| Fourth cell of a table
| Fifth cell of table | Sixth cell of a table |
| First cell of a table | Second cell of a table | Third cell of a table| Fourth cell of a table
| Fifth cell of table | Sixth cell of a table |
| First cell of a table | Second cell of a table | Third cell of a table| Fourth cell of a table
| Fifth cell of table | Sixth cell of a table |
| First cell of a table | Second cell of a table | Third cell of a table| Fourth cell of a table
| Fifth cell of table | Sixth cell of a table |
| First cell of a table | Second cell of a table | Third cell of a table| Fourth cell of a table
| Fifth cell of table | Sixth cell of a table |
| First cell of a table | Second cell of a table | Third cell of a table| Fourth cell of a table
| Fifth cell of table | Sixth cell of a table |
| First cell of a table | Second cell of a table | Third cell of a table| Fourth cell of a table
| Fifth cell of table | Sixth cell of a table |
| First cell of a table | Second cell of a table | Third cell of a table| Fourth cell of a table
| Fifth cell of table | Sixth cell of a table |
```

9.2 Appendix 2

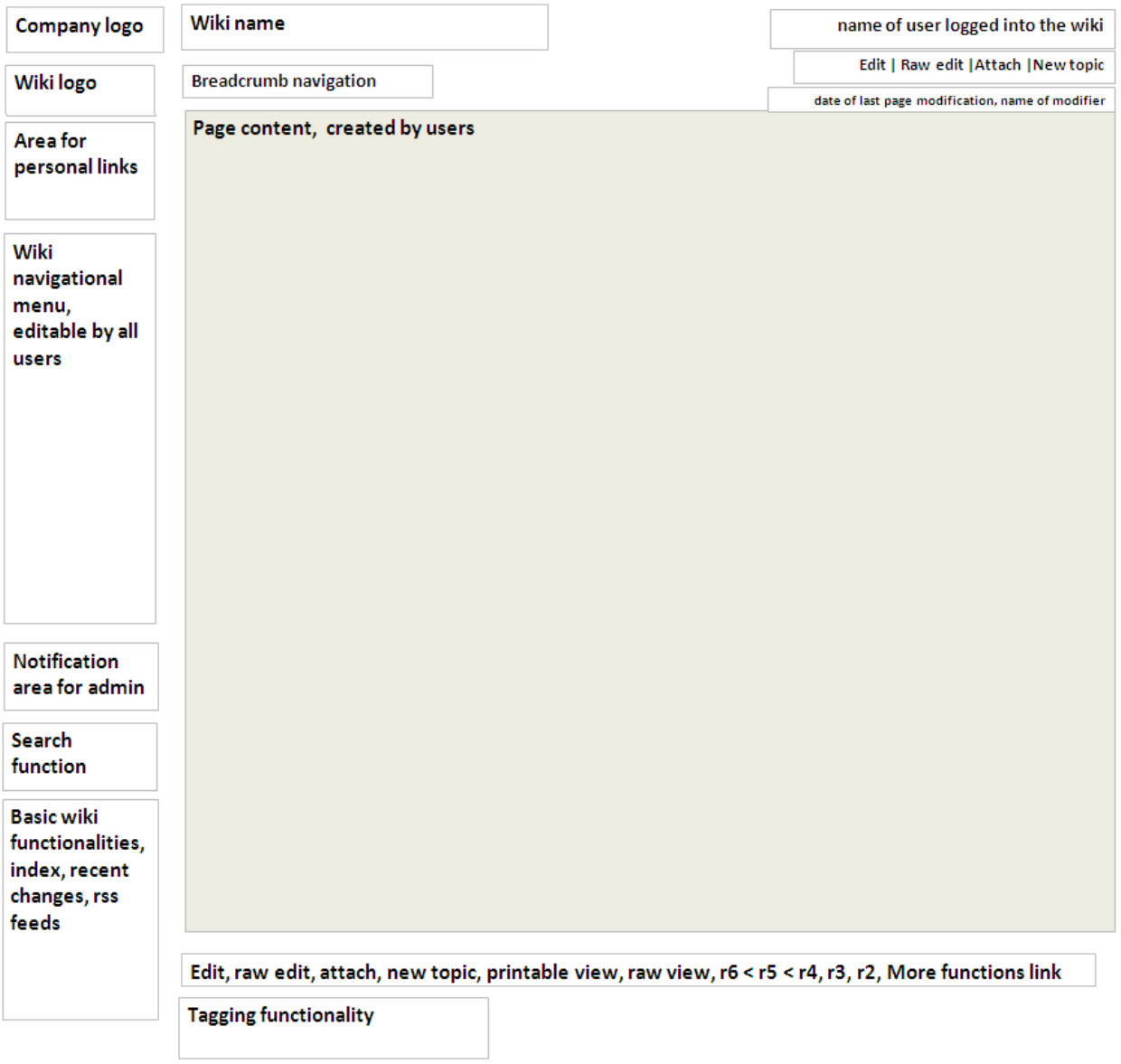
The example table shown in Appendix 1 being edited using the edit table plugin.

Table heading	Table Heading	Table Heading	Table Heading	Table heading	Table heading
First cell of a table	Second cell of a table	Third cell of a table	Fourth cell of a table	Fifth cell of table	Sixth cell of a table
First cell of a table	Second cell of a table	Third cell of a table	Fourth cell of a table	Fifth cell of table	Sixth cell of a table
First cell of a table	Second cell of a table	Third cell of a table	Fourth cell of a table	Fifth cell of table	Sixth cell of a table
First cell of a table	Second cell of a table	Third cell of a table	Fourth cell of a table	Fifth cell of table	Sixth cell of a table
First cell of a table	Second cell of a table	Third cell of a table	Fourth cell of a table	Fifth cell of table	Sixth cell of a table
First cell of a table	Second cell of a table	Third cell of a table	Fourth cell of a table	Fifth cell of table	Sixth cell of a table
First cell of a table	Second cell of a table	Third cell of a table	Fourth cell of a table	Fifth cell of table	Sixth cell of a table
First cell of a table	Second cell of a table	Third cell of a table	Fourth cell of a table	Fifth cell of table	Sixth cell of a table
First cell of a table	Second cell of a table	Third cell of a table	Fourth cell of a table	Fifth cell of table	Sixth cell of a table
First cell of a table	Second cell of a table	Third cell of a table	Fourth cell of a table	Fifth cell of table	Sixth cell of a table
First cell of a table	Second cell of a table	Third cell of a table	Fourth cell of a table	Fifth cell of table	Sixth cell of a table
First cell of a table	Second cell of a table	Third cell of a table	Fourth cell of a table	Fifth cell of table	Sixth cell of a table
First cell of a table	Second cell of a table	Third cell of a table	Fourth cell of a table	Fifth cell of table	Sixth cell of a table

Save table | Quiet save | Add row | Delete last row | Cancel

9.3 Appendix 3

Wireframe model of original wiki user interface used by the case company



9.4 Appendix 4

Wireframe model of the new wiki user interface after modifications were made in Phase 2.