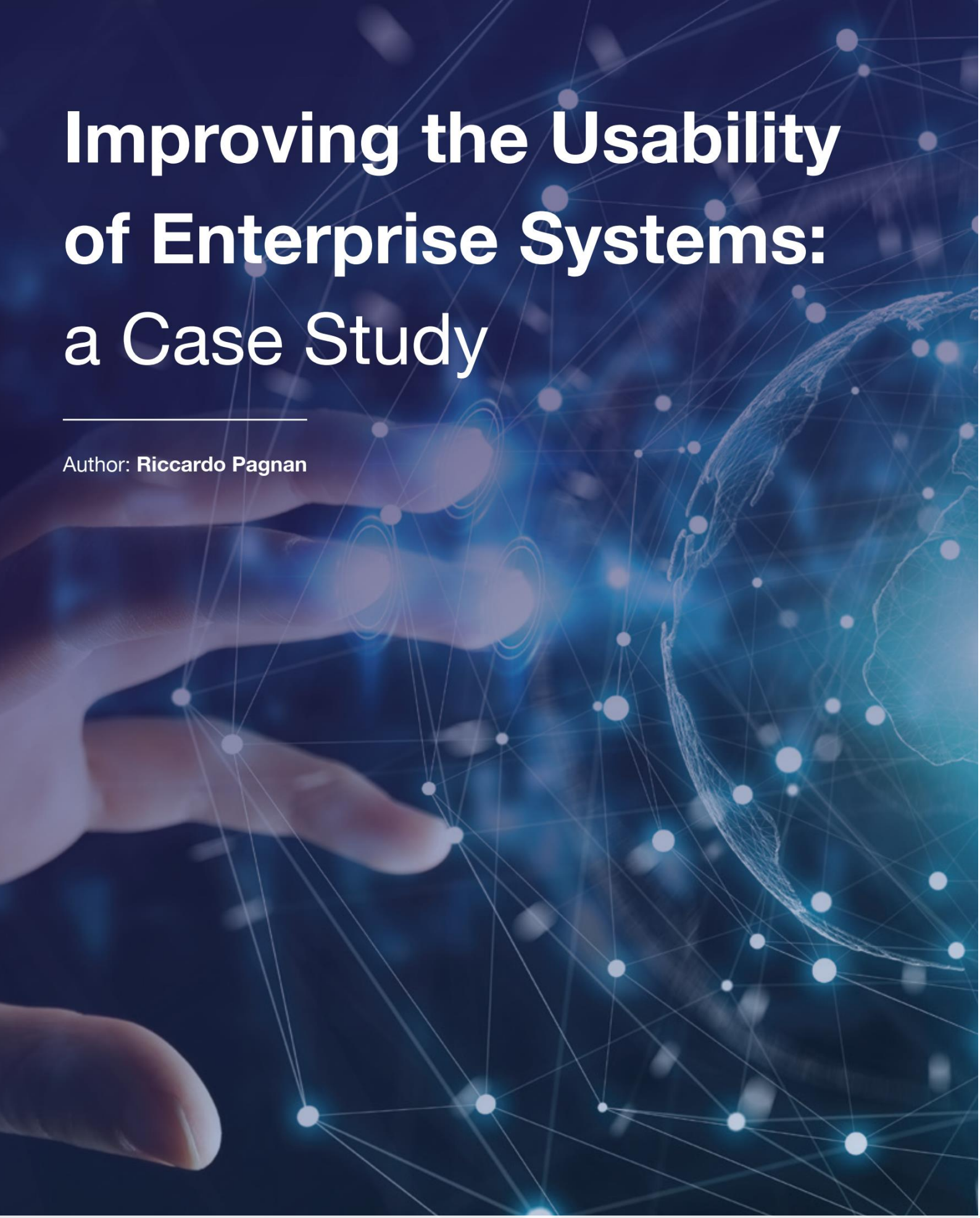


Improving the Usability of Enterprise Systems: a Case Study

Author: **Riccardo Pagnan**

TU Delft

AkzoNobel
Tomorrow's Answers Today

Improving the Usability of Enterprise Systems: a Case Study

Master thesis submitted to Delft University of Technology
in partial fulfilment of the requirements for the degree of

MASTER OF SCIENCE

in

Management of Technology

Faculty of Technology, Policy and Management

by

Riccardo Pagnan

Student number: 4946618

To be defended in public on July 17th, 2020

Graduation committee

Chairperson	: Dr. R. M. Verburg, Economics of Technology and Innovations
First Supervisor	: Dr. R. M. Verburg, Economics of Technology and Innovations
Second Supervisor	: Ir. M. W. Ludema, Transport and Logistics
External Supervisor	: M. Soufivand, AkzoNobel Decorative Coatings B. V.

Acknowledgements

Firstly, I would like to express my sincere gratitude to **Dr. Robert M. Verburg** for his crucial support and professional guidance provided throughout the entire thesis-writing process. Our constructive conversations were something to look forward to, especially during the strenuous times of the quarantine. I would also like to extend my gratitude to **Ir. Marcel W. Ludema** for his honest feedback and valuable help throughout these months.

It is of utmost importance to also highlight a fundamental partner for this thesis: AkzoNobel, personified by **Mona Soufivand** and by **Ir. Sander Meeder**. I am particularly grateful for all the support they have given me from the very first moment I stepped foot in Sassenheim, as well as for all their kind attention and support during the internship. I can state with certainty that my experience at AkzoNobel was the most formative of my academic years and I learned a great deal by observing these inspiring supervisors and helping them in carrying out the successful SharePoint project. It was my absolute privilege to have had the opportunity to work with them, and I hope for such privilege again in the future.

I would also like to express my deep gratitude to **Dr. Jurek Kirakowski, Director of User Experience Solutions,** for his advice and assistance. He supported me with his expertise and professionalism, providing me with a free academic license to use his work and helping me analyse the data. His availability and willingness to gift me with his precious time so generously were very much appreciated.

Executive Summary

Introduction

This thesis proposes **a set of guidelines to improve the usability of Enterprise Systems (ESs) for knowledge sharing and collaborative work**.

The study starts with a literature review of the key concepts, which are defined as follows:

- **Knowledge:** the ability to discriminate within and across contexts, enabling to act based on a belief that is correct and justified.
- **Knowledge sharing:** the process of codifying information to enable knowledge development, selection, exchange and use.
- **Software usability:** a set of features that allow a satisfactory user experience (ISO, 2011).
- **Enterprise Systems:** software for knowledge sharing where information is stored across and within functions and departments of a company.

The objective of the research is then translated into the following research question:

How can companies improve the usability of their Enterprise Systems?

The main research question was then split into two sub-parts to achieve a comprehensive set of guidelines. These two sub-parts represent, respectively, the reasons why users may decide not to use ESs (**barriers**) and the set of features that increase ESs usability (**functionalities**).

The research sub-questions connected to the two parts are the following:

(1.1) How can the barriers of Enterprise Systems be overcome?

(1.2) What are the functionalities that Enterprise Systems should have?

Methodology

The methodology used for this thesis consisted of a literature review and a case study. The case study was a high-priority project in one of the four key initiatives of AkzoNobel for 2020, and it consisted of the redesign of the ES of the department of Decorative Coatings.

The first set of guidelines was identified during the literature review. These were then complemented by further guidelines developed during an exploratory round of sixteen interviews carried out at the beginning of the case study. These interviews saw the participation of one high-level executive, five middle-level managers and ten planners.

After their development, all guidelines were implemented during the redesign project. At the end of the project, each guideline was validated individually through six interviews, which comprised five planners and one middle-level manager.

In addition to the qualitative evaluation of the guidelines, the study also has a strong quantitative component. In fact, the impact of the guidelines was measured analytically via two questionnaires, sent before and after the redesign. The tool used to measure the impact is the SUMI questionnaire, the *de facto* industry standard to evaluate software usability.

The SUMI divides software usability into five parameters, which are defined by Kirakowski (1993) as follows:

- **Affect:** The respondents' feeling that the ES is stimulating and pleasing to use.
- **Controllability:** The feeling that the ES is responding consistently with the expectations of the user.
- **Efficiency:** The respondents' feeling that the ES is enabling them to work quickly, effectively and simply.
- **Helpfulness:** The degree to which the ES assists users in solving operational problems.
- **Learnability:** How straightforward it is for users to become familiar with the ES.

Results

The results of the thesis are guidelines on barriers and functionalities of ESs, drawn from a literature review and a case study.

The guidelines on barriers from the literature review target **perceived ease of use** and **perceived usefulness**. In brief, measures for the first category aim to make ESs more efficient and easy to use, while those about perceived usefulness target effectiveness and quality of results.

Throughout the case study, barriers were identified in terms of **lack of maintenance** and **difficulty in finding documents**. The guidelines propose to overcome the first by tackling the lack of knowledge of users via FAQ sections, manuals and tutorials. Secondly, regular time windows for updates and maintenance are proposed. The third and last group of guidelines suggest centrally storing documents and limiting authorisations.

Concerning the functionalities from the literature review, the first two sets of guidelines are interconnected and are at the heart of knowledge-sharing: **depositing** and **searching knowledge**. The research concluded that information should be stored centrally and with a balanced aim between exploiting pre-existing knowledge and exploring new knowledge.

Secondly, the **search functionality** within ESs was broken down and analysed. The features identified as beneficial to the user experience included showing the most relevant results on top of the page with a preview, as well as enabling search by the content of documents and not just their title.

The third group of guidelines analysed **social collaboration**. For this aspect, the literature suggests that ESs should include users' profiles with information about their role. These profiles should be searchable by other users so that colleagues can learn about each other as well as get in touch with others.

The last aspect explored was the **interface**, which in the literature has a dual focus on modularity and vanilla implementation. The guidelines combine these two elements by suggesting a division of the interface into sections that are kept simple and have minimal customisation.

Four main groups of guidelines for functionalities were also identified during the case study. First, a **One-Click System** was implemented to limit the frequency of refreshing pages. Second, the interviewees expressed the need to have all elements in **one screen** without a need to scroll vertically or horizontally. The third set of measures concerned the **search** function, which was improved by adding previews and by limiting its scope to relevant content. Last but not least, **standardisation** was discussed in light of its vital role to facilitate information exchange and streamline job rotation.

In addition to the qualitative results, this thesis contributed with a quantitative measurement of the guidelines described. For that, the usability of the ES was measured with SUMI questionnaires before and after the redesign. Then, the results of the questionnaires were compared via unpaired t-tests, showing a statistically relevant increase in all parameters of usability.

More specifically, the increases were:

- *Affect*: +15%
- *Controllability*: +10%
- *Efficiency*: +23%
- *Global:* +20%
- *Helpfulness*: +15%
- *Learnability*: +20%

Limitations

This research is based on only one case study, which entails low external validity. In other words, the results cannot be generalised to other companies in the Netherlands or all planning departments.

At the same time, this research was designed with a solid combination of qualitative and quantitative elements to tackle these limitations, which are characteristic to case studies. Indeed, two rounds of in-depth interviews were carried out, and a variety of employees were interviewed to validate the results.

Furthermore, two questionnaires measured the impact of the guidelines, showing that the improvements in software usability are statistically significant on all grounds.

Contributions

First and foremost, this research provides guidelines that can be used by companies to increase the usability of their ESs. Indeed, the guidelines are drafted to be easily adaptable to different contexts by following the same procedure of the case study.

Furthermore, this case study contributes to the literature on ESs. The strongest element of this research is its unique combination of qualitative and quantitative elements, which constitutes a novelty compared to similar researches.

Table of Contents

LIST OF TABLES

LIST OF FIGURES

To my family and everyone that has been there for me.

1. Introduction

In today's interconnected and dynamic world, sharing knowledge within a company and streamlining its workflow can be a significant source of competitive advantage. Studies from Silic and Back (2016) and Williams and LaBrie (2015) show that collaborative applications are a driver of productivity in enterprises. Moreover, embedding knowledge into systems instead of people and facilitating the knowledge exchange within a company can be critical to becoming more efficient and leaner (Battleson et al., 2016; Kranz et al., 2016). Interestingly, a study from Naim and Lenkla (2016) delves even further and shows that knowledge sharing has the potential not only to foster competency development but also to increase retention rates of some employees. Embedding knowledge into systems and increasing the absorptive capacity of the company to enhance the competences of employees is precisely the idea behind an Enterprise System (ES).

However, human interaction with technology is often unpredictable, and technologies themselves are not a panacea. Quite often, the solutions that software can offer in theory do not immediately translate into a competitive advantage in practice. Indeed, the very idea of technologies as carriers of "best practices" is in itself largely dependent on how users interact with technology, the specificity of the context, the restrictions on flexibility and the creation of competitive value (Newell et al., 2009). For example, the introduction of a new ES can have a limited impact on the productivity of a company if users oppose it and stick to their offline databases.

Besides these considerations, ESs present challenges linked to the nature of knowledge as well as to workforce turnover. In fact, not all information can be codified easily, and implicit knowledge is, by definition, hard or impossible to translate into manuals. Hence, when knowledge-workers leave, their know-how also leaves with them, and companies suffer significant losses (Urbancová, 2012). Their knowledge and skills may never be recovered also because part of the expertise of these workers can be the ability to access information. In this case, the loss would be in terms of both implicit and explicit knowledge. The latter, which refers to information that can be codified and

stored easily, is the core of the issue that was analysed as part of the research through a case study in AkzoNobel Decorative Coatings B.V.

Before delving into the problem statement and the case study, the forthcoming paragraphs have the following focus.

Paragraph 1.1 defines essential concepts for the thesis, which are the first critical steps to understand the topic of this thesis.

Paragraph 1.2 provides background on the type of problem analysed by this thesis.

Paragraph 1.3 describes the research objective and presents the research question and sub-questions.

Paragraph 1.4 outlines the research procedure.

Paragraph 1.5 provides an overview of the thesis and concludes the introductory chapter.

1.1 Topic Definition

The purpose of this paragraph is to define the keywords pertaining to this thesis. Since this thesis focuses on knowledge sharing via ESs, it is crucial to define first and foremost the concepts of knowledge, knowledge transfer and ESs.

1.1.1 Knowledge

> *When you know a thing, to recognise that you know it. And when you do not know a thing, to recognise that you do not know it. That is knowledge.*
> *- Confucius*

Knowledge is a concept that has been studied for millennia by many of the world's brightest minds. Its intangible nature and its ability to evolve are only some of the aspects that make it difficult to define. For the purposes of this thesis, the definition of knowledge was based on the works of several authors, such as Hunt (2003), Newell et al. (2009), Plotkin (1997), Sveiby (1997), Swan and Scarbrough (2005) and Ward et al. (2009). These authors were specifically chosen since the combination of their works could best contribute to a comprehensive definition that is also relevant to the context of ESs.

On that account, for the rest of this thesis, knowledge is defined as:

The ability to discriminate within and across contexts, enabling to act based on a belief that is correct and justified.

Newell et al. (2009, p. 5) and Swan (2008) define knowledge as "ability to discriminate within and across contexts". The aspect of "within and across contexts" is especially relevant for ESs because they train users both in their job (within context) and cross-functionally (across contexts).

Building upon the fact that information should be translated into knowledge to enable users to develop competencies, the second half of the definition starts by saying that knowledge should enable to act. This objective has been identified as core in the transfer of knowledge within an enterprise because said knowledge should lead to

competencies and hence to the ability to fulfil the tasks connected to one's job. If the belief upon which actions are based is not compelling enough for a person to act upon, then knowledge-sharing within the enterprise does not serve its practical purpose.

Moreover, the definition states that the belief should be correct and justified, adding two critical dimensions to the concept of knowledge.

The first dimension is self-explanatory: the knowledge transferred through an ES must be accurate. If an action is grounded upon an incorrect belief, then it may not be successful. Hence, the mechanism is flawed.

The second dimension is essential because employees act based on what they believe to be correct due to a reason. As explained by Hunt (2003) and Plotkin (1997), if a belief is correct but not justified, it may be wrong if applied to a different context. To briefly explain the importance of this, the following example is presented. If one were to calculate the square root of 36 and did so by using a calculator, the answer would be six. In this case, the belief would be correct and justified by the belief that calculators provide accurate solutions. If one decided to instead carry out that calculation by throwing a six-faced dice, the answer could be any number between one and six. If the result of the throw were six, then the belief would be correct, but based on chance and therefore not justified. This example is an evident exaggeration since no one would calculate the square root of a number by throwing a dice. Still, it explains the importance of one's beliefs to be justified and not merely correct.

1.1.2 Knowledge Transfer in the Literature

After having defined the concept of knowledge, the second step is to define what knowledge transfer is. The definition adopted by this thesis is centred around the theory of epistemology of possession, which states that knowledge is "embrained and embodied in the skills and heads of individuals or organisation" (Newell et al., 2009, p. 18).

Other perspectives present different views on the nature of knowledge, such as the epistemology of practice. However, by definition, this perspective is incompatible with knowledge sharing since the knowledge shared via ESs is neither "encultured in a social context" nor "embedded in practice" (Newell et al., 2009, p. 18). Hence, it can

be concluded that the epistemology of practice is out of the scope of this thesis. For that reason, this theory is not discussed further.

Within the epistemology of possession, one of the most popular frameworks for knowledge transfer was developed by Nonaka (1994). In his SECI, which stands for Socialisation, Externalisation, Combination and Internalisation, Nonaka (1994) claims that knowledge transfer between individuals happens in a spiral of interactions between implicit and explicit knowledge. For that, he describes the following four processes:

- **Socialisation (implicit to implicit):** the process of sharing knowledge via face-to-face interactions, where tacit knowledge is acquired through shared experiences.
- **Externalisation (implicit to explicit):** the codification of knowledge, which becomes explicit from implicit. Examples of this include writing articles or drawing images.
- **Combination (explicit to explicit):** the integration of different pieces of knowledge. Information is gathered from inside and outside the organisation, and it is then combined and disseminated throughout the company.
- **Internalisation (explicit to implicit):** the process of learning by doing, where explicit knowledge is internalised by an individual and becomes an asset of this person.

The SECI model by Nonaka (1994) is essential for this thesis because it describes how ESs should facilitate knowledge sharing. Indeed, ESs should be the tool through which users codify their knowledge via *Externalisation* and later assimilate this knowledge via *Internalisation*.

Furthermore, *Socialisation* and *Combination* can also contribute to ESs and knowledge transfer. The first describes how employees share the knowledge that they have acquired in the ES. Examples of this include learning something via the ES and later sharing this knowledge with other colleagues during formal or informal meetings. On the other hand, *Combination* describes how employees disseminate throughout the ES some knowledge that they have acquired from outside. For instance, employees

that take part in advanced formation courses can then share this knowledge with their colleagues via the ES.

The SECI model is schematised in Table 1, with a graphical representation of the spiral.

Table 1. SECI (adapted from Nonaka, 1994)

	IMPLICIT	EXPLICIT
IMPLICIT	Socialisation	Externalisation
EXPLICIT	Internalisation	Combination

After the work of Nonaka, the concept of knowledge was refined by Spender (1996), who extended the locus of knowledge to social entities. In his work, Spender (1996) defined the following four types of knowledge based on locus and codifiability.

- **Automatic:** implicit knowledge that belongs to the individual, such as the ability to swim.
- **Conscious:** explicit knowledge that belongs to the individual, such as the ability to read and write.
- **Objectified:** explicit knowledge that belongs to the group, such as manuals and tutorials.
- **Collective:** implicit knowledge that belongs to the group, such as the culture of an organisation.

This model is particularly relevant for this thesis because it can be used to describe knowledge sharing via ESs. Indeed, while the SECI helps to describe the process of knowledge transfer, the framework from Spender (1996) further details the type of knowledge that is transferred.

Within ESs, the first step of knowledge sharing happens when automatic knowledge is translated into conscious, so that it can be codified. Then, conscious knowledge is

uploaded in the ES, where it becomes objectified. Eventually, this knowledge is translated into collective and automatic knowledge via *Internalisation*.

These concepts are schematised in Table 2 below, which describes how the SECI can be applied to Spender's model.

Table 2. SECI Model applied to Spender's Framework (adapted from Nonaka 1994; Spender 1996).

	IMPLICIT	EXPLICIT
INDIVIDUAL	Automatic	Conscious
SOCIAL	Collective	Objectified

Despite the valuable addition of an ontological dimension, Spender's model is limited because it does not detail the location where knowledge is stored.

For that, a few years later, Nonaka and Konno (1998) re-elaborated the SECI model by defining the concept of 'ba': a physical, virtual or mental location where knowledge is embedded and acquired from individuals. More specifically, they defined the following four 'ba':

- **Originating 'ba':** the place where individuals share experiences.
- **Interacting 'ba':** the place where peers engage in dialogue.
- **Cyber 'ba':** the place where knowledge is combined and made available throughout the organisation.
- **Exercising 'ba':** the place where knowledge can be applied through job training and active participation.

The addition of a locus for knowledge is vital for this thesis, which is based on facilitating knowledge sharing via ESs. For that, it is apparent that the cyber 'ba' is the most relevant locus since ESs are, by definition, virtual places.

1.1.3 Working Definition of Knowledge Transfer

For the purposes of this thesis, knowledge transfer is defined as:

The process of codifying information to enable knowledge development, selection, exchange and use.

The first part of the above definition starts by claiming that knowledge translation is the process of codifying information. As described by Ackoff (1988), knowledge derives from information. Hence, to exchange knowledge through an ES, one must first codify said knowledge.

The second part of the statement is linked to the definition of knowledge (subparagraph 1.1.1). The first step, knowledge development, is the acquisition and internalisation of information that forms the justified belief. Knowledge selection is in itself the ability to discriminate within and across contexts, which is the first part of the definition of knowledge. Knowledge exchange is a self-fulfilling part of the definition since information exchange within ESs should lead to knowledge exchange. Knowledge use closes the definition by stating that the aim of transferring knowledge is not only to develop new abilities and skills but also to act upon them. This aspect goes back once again to the definition of knowledge previously presented, which states that knowledge enables to act upon a belief.

The idea of dividing knowledge translation into four moments is based on the work of Ward et al. (2009). Their model went further and presented two additional phases that were excluded to simplify the definition and make it more relevant to ESs. These phases are “problem identification and communication” and “analysis of context”. They were excluded because they occur before knowledge transfer, which is beyond the scope of this thesis – improving ESs’ usability.

1.1.4 Enterprise Systems Usability

To define the usability of ESs, this thesis adopts the definition of software usability by the International Organization for Standardization (ISO). Therefore, ESs' usability is going to be defined as:

A set of features that allow an effective, efficient and satisfactory user experience (ISO, 2011).

In addition to this, the ISO (2011) also defines the following six sub-characteristics of usability:

- **Appropriateness Recognisability:** The degree to which users recognise that an ES can solve their needs.
- **Learnability:** How easily users can learn to use an ES effectively and efficiently.
- **Operability:** How easy it is to operate and control an ES.
- **User Error Protection:** The degree to which an ES prevents user errors.
- **User Interface Aesthetics:** How pleasing and satisfying it is for users to interact with the interface of the ES.
- **Accessibility:** The degree to which an ES can be used by people with the widest range of characteristics and capabilities.

These sub-characteristics are fundamental to get a comprehensive understanding of software usability as well as to be able to evaluate it quantitatively. In order to do so, the work of the ISO (2011) is complemented by Kirakowski (1993), who proposes to evaluate software usability based on a set of five parameters. These five parameters are measurable through his Software Utilisation Measurement Index (SUMI) questionnaire, which is an integral component of this thesis.

The reasons why this thesis uses a questionnaire to evaluate ESs' usability, and why the SUMI questionnaire was selected over other tools, are to be found in the literature.

First of all, only questionnaires that featured rating scales were considered since these are the most frequent and effective tool to gather quantitative results on user experience (Lazar et al., 2017).

As for the identification of a specific questionnaire, Hinderks et al. (2019, p. 16) compared the most used tools and concluded that "none of the established questionnaires can measure user experience to its full extent [...] Ideally, the questionnaire should measure all the factors the user considers important". Therefore, the work of Hinderks et al. (2019) was used to compare different questionnaires and understand which one was the most adequate for this thesis. As a result, the SUMI by Kirakowski (1993) was selected because it covered all aspects of software usability. Moreover, all problems encountered by the company in the case study could be connected to one of the five parameters evaluated by the SUMI, which Kirakowski (1993) defined as follows:

- **Affect:** The respondents' feeling that the ES is stimulating and pleasing to use.
- **Controllability:** The feeling that the ES is responding consistently with the expectations of the user.
- **Efficiency:** The respondents' feeling that the ES is enabling them to work quickly, effectively and simply.
- **Helpfulness:** The degree to which the ES assists users in solving operational problems.
- **Learnability:** How straightforward it is for users to become familiar with the ES.

Furthermore, the SUMI was selected because of its compatibility with the definition of software usability by ISO. Indeed, both definitions present the aspects of Learnability and Efficiency. *Controllability* and *Operability,* as well as *Helpfulness* and *Appropriateness Recognisability,* are de facto identical. *Affect*, as defined by Kirakowski (1993), is similar yet more thorough than the *User Interface Aesthetics* from the ISO (2011) because it touches upon the whole user experience and not just the graphics. The ISO (2011) also includes *User Error Prevention*; Kirakowski (1993) divides this parameter between *Learnability* and *Efficiency*.

The questionnaire and more information about how it operates can be found in Appendix D.

1.2 Problem Description

The literature on knowledge management over the past three decades has highlighted the vital role of knowledge and its management for companies that want to be successful in today's complex socioeconomic landscape (Barley et al., 2018).

In the sphere of knowledge management with ESs, the literature consistently shows that firms which invest in ESs tend to perform better financially (Chuang & Tin-Chang Chang, 2012; Hitt et al., 2002; Sabherwal & Sabherwal, 2005). A study by Elgohary (2019) goes beyond the financial aspect by claiming that ESs are a crucial requirement to achieve competitive advantage. Furthermore, a study by Naim and Lenkla (2016) also shows a positive correlation between ESs and employee retention.

Despite the several advantages, many companies face a variety of problems with ESs. Indeed, Markus and Tanis (2000) argue that companies experience problems from the adoption until the last phases of an ES life cycle. Moreover, Grove et al. (2018) proved an overarching theme of ESs: they are difficult to put in practice for knowledge-management because companies tend to focus on creating immediate value rather than investing on long-term profitability. The same study showed that if a company prioritised establishing a collaborative environment, ESs would facilitate an integrated way of working. Hardwig et al. (2019) further built on that by proving empirically that software-supported collaboration brings higher benefits for more complex actions. However, operating on complex tasks may bring up another problem of ESs: technology underutilisation, namely a low utilisation of the technology from the employees. In fact, Venkatesh and Bala (2008) suggest that this phenomenon can constitute a "major barrier to successful IT implementation".

In summary, successful usage of ESs is important for companies to generate competitive advantage, as highlighted by Hitt et al. (2002), Elgohary (2019) and Naim and Lenkla (2016). However, challenges may arise in the adoption, implementation or usage of an ES as shown by Markus and Tanis (2000). Grove et al. (2018) highlighted some of the difficulties in effective implementation of knowledge management systems, and Hardwig et al. (2019) suggested that companies operating on complex tasks can benefit the most from successful knowledge-sharing. Therefore, tackling the challenges of ESs in a real-life scenario is a compelling subject of a case study.

1.2.1 Enterprise Systems

Before moving to the research objective, it is fundamental to clarify what type of ES is the object of the study since the literature provides an abundance of definitions for ESs (Al-Mashari et al., 2003; Fui-Hoon Nah et al., 2001; Hitt et al., 2002; Newell et al., 2009).

The type of ES that is the object of this research operates with different types of knowledge and spans across different functions and departments of a company. The aim is indeed to investigate what Nonaka and Konno (1998) described as cyber 'ba', the virtual place where knowledge can be shared between individuals. Moreover, the type of knowledge subject of this study can be described in the words of Blackler (1995) as embedded in technologies, rules and procedures before becoming part of collective understanding.

Interestingly, studies by Balle et al. (2019) and Bouncken and Aslam (2019) show that knowledge sharing happens regardless of the type of knowledge and that the creation of a shared space can facilitate sharing of implicit knowledge. ESs can represent this shared space, as they aim to enable individuals to acquire knowledge.

In conclusion, to summarise the considerations above, ESs are defined as:

Software for knowledge transfer where information is stored across and within functions and departments of a company.

1.3 Research Objective

The objective of the research is to **provide a set of guidelines to improve the usability of ESs for knowledge sharing and collaborative work**. This objective stems from the problem description, which described how companies often struggle to achieve a successful implementation of ESs.

This objective translates into the following main research question:

How can companies improve the usability of their Enterprise System?

The research question is split into two sub-parts to facilitate the research. These parts are the barriers to ESs and the functionalities of ESs. Intuitively, the barriers represent the reasons why users may decide not to use an ES. In contrast, the functionalities represent the other side of the coin, namely the reasons why users decide to use an ES.

The research was then split into these two parts based on the assumption that ESs are effectively designed if they overcome barriers against their usage and sustain their value over time thanks to their functionalities.

Hence, the research sub-questions are:

(1.1) How can the barriers of Enterprise Systems be overcome?

(1.2) What are the functionalities that Enterprise Systems should have?

1.4 Research Procedure

This paragraph presents the procedure used to respond to the research question.

First of all, a literature review was carried out on the two parts that characterise this thesis: barriers to ESs and functionalities of ES. This literature review aimed to develop guidelines to be implemented and tested during the case study.

The case study started with a round of interviews to evaluate barriers and functionalities of the ES. In parallel, a survey was sent to the department to measure the usability of the ES before the redesign. Overall, this first screening revealed several barriers and functionalities of the ES, which were translated into guidelines for the redesign project.

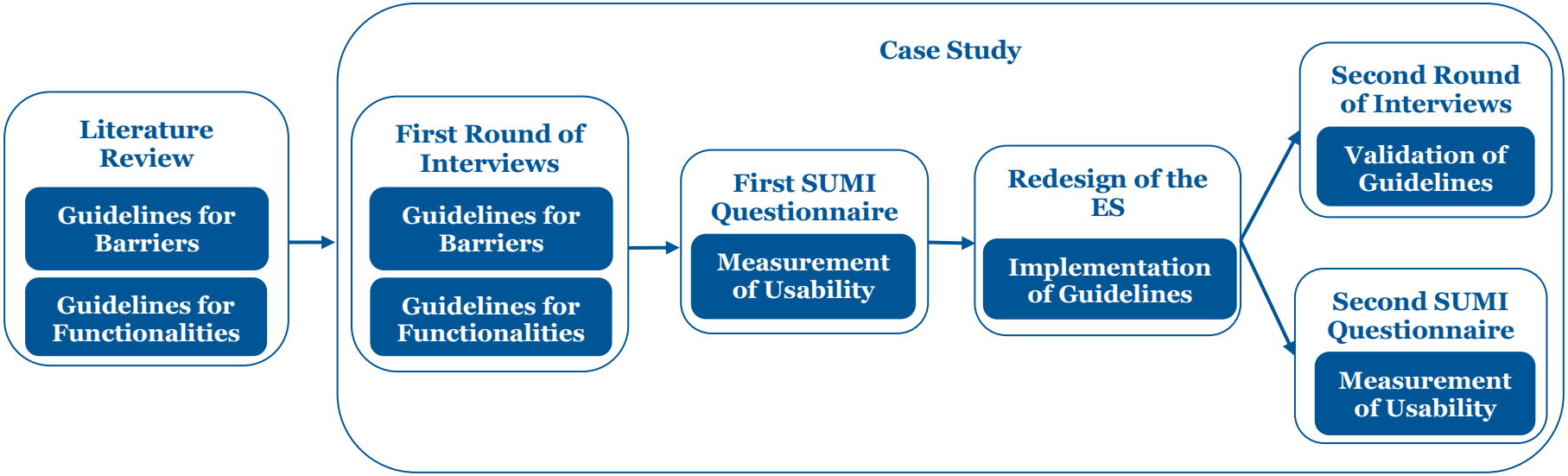
The subsequent step of the research was a practical one, and it consisted of restructuring the ES according to the guidelines developed during the literature review and the interviews.

After the redesign project was completed, the second round of interviews took place to validate the guidelines. During these interviews, all guidelines from the literature and case study were examined individually with the interviewees. Additionally, a second survey was sent to a sample of the department to measure the impact of the redesign.

After the results of the survey were collected, a statistical analysis was conducted. Since the respondents to the two questionnaires were not identical, the procedure consisted of unpaired t-tests on all parameters.

The overall procedure is schematised in Figure 1 on the next page. More details on the methodology used for the literature review and the case study are presented, respectively, in paragraphs 2.1 and 3.1.

Figure 1. Research Procedure



Legend

Activity

Result

1.5 Thesis Overview

This paragraph concludes the introduction and describes the structure of the thesis and the deliverables.

- Chapter 1 introduced the topic. It defined the most crucial concepts, located the topic in the literature and presented the research objective and procedure.

- Chapter 2 presents the literature review. The first part describes the methodology. The second and third parts present the most relevant literature on barriers to ESs and functionalities of ESs.

- Chapter 3 shows the findings of the case study. It starts by presenting the background of the case study and its methodology. Then, it continues with a description of the barriers followed by the functionalities. Eventually, the analytical results of the thesis are discussed.

- Chapter 4 concludes the thesis by comparing and linking the results of the literature review with those of the case study. The last paragraphs describe the contribution and limitations of the case study as well as the potential for further research.

2. Literature Review

A first literature review on the theories of knowledge, knowledge transfer, software usability and ESs was conducted to formulate and present the introductory concepts. The purpose of this initial literature review was to locate the subject of the thesis in the literature and to define the most critical notions. Secondly, a literature review was conducted to identify the most common barriers to ESs and the most requested features of ESs according to the literature.

This chapter describes the second literature review. In particular, paragraph 2.1 introduces the methodology, while paragraphs 2.2 and 2.3 address research sub-questions 1.1 and 1.2.

2.1 Literature Review Methodology

The search engines used during the literature review were Scopus and Google Scholar, with some additions from the Journal of Knowledge Management. The latter was chosen because of its affinity with the focus of this thesis – knowledge management.

The primary criteria for selection of the articles concerned the keywords, which were refined several times and revolved around the concepts of knowledge, knowledge sharing/transfer, Enterprise Resource Planning (ERP), ESs, knowledge-management systems (KMSs). Further keywords used were connected to barriers, functionalities, software, usability and graphical user interfaces. The words were searched in different combinations both in the publication's title, abstract and keywords.

The search results were listed first on their relevance and then on their date, with the most recent publications shown first. This process aimed to include in the literature review both the most important papers and the most recent ones. For each word or combination of words and filters, the title of the first 40 results was read. Of these, between 20 and 30 abstracts were further studied each time. Out of the studied abstracts, only articles that were deemed relevant were selected and reviewed in full.

2.2 Barriers of ESs

This paragraph presents a literature review on the barriers of ESs, which are defined as the reasons why potential users decide not to use the ES.

The literature identifies a variety of obstacles for technology adoption and implementation (Salahshour Rad et al., 2018). Therefore, it is important to remind that the purpose of this thesis is to provide a set of guidelines to improve the usability of ESs for knowledge sharing and collaborative work. Hence, only barriers that are hindering these processes are considered.

The theory from the literature is presented in subparagraphs 2.2.1 and 2.2.2. After that, an analysis of the literature is conducted in subparagraph 2.2.3, leading to the guidelines presented in Table 3.

2.2.1 Barriers to Adoption

Technology adoption can be defined as the acceptance and first use of technology (Kijsanayotin et al., 2009). One of the most popular frameworks to evaluate this process is the Technology Adoption Model (TAM), developed by Davis (1989). This model summarises the barriers of technology adoption into two categories: perceived ease of use and perceived usefulness, with the latter being significantly more important than the first one.

This model was then refined by Venkatesh and Davis (2000), who proposed an extension to TAM 2 by adding the social influence process and the cognitive instrumental process.

The social influence process focuses on the impact of software on individual users by adding the subjective norm, voluntariness and image of software.

On the other hand, the cognitive instrumental process is centred on the effectiveness of software. The parameters added include job relevance, output quality, result demonstrability and perceived ease of use.

The TAM and TAM 2 are key frameworks for this thesis since they help to understand the root causes behind accepting and utilising technologies such as ESs. Indeed, these

models rely on a straightforward assumption: users decide to use the software if its perceived value (usefulness) is worth its perceived cost (difficulty of use). For this reason, the upcoming subparagraphs will outline how TAM and TAM 2 can be used not only to describe the acceptance of ESs but also their usage in daily activities.

For completeness, it is important to mention that TAM2 was further refined by Venkatesh and Bala (2008) in their latest extension to TAM3. This model was excluded from the literature review because it focused on psychological parameters such as computer anxiety and perceived enjoyment, which are outside of the scope of this thesis.

2.2.2 Barriers to Diffusion

As previously expressed, the objective of the guidelines is to ensure that the value added by ESs is sustained over time. Therefore, it is vital to investigate the step after technology adoption: its diffusion. Hence, this subparagraph describes the most famous model on how technologies can overcome the barriers to diffusion: the Diffusion of Innovation (DOI) by Rogers (2010).

In his model, Rogers identifies five key parameters for technologies to overcome barriers to diffusion.

- **Compatibility:** "The degree to which an innovation is perceived as being consistent with the existing values, past experiences and needs of potential adopters" (Rogers, 2010, p. 16).
- **Complexity:** "The degree to which an innovation is perceived as difficult to understand and use" (Rogers, 2010, p. 16).
- **Observability:** "The degree to which the results of an innovation are visible to others" (Rogers, 2010, p. 16).
- **Relative advantage:** "The degree to which an innovation is perceived as being better than the idea it supersedes" (Rogers, 2010, p. 16).
- **Trialability:** "The degree to which an innovation may be experimented with on a limited basis" (Rogers, 2010, p. 16).

Before drafting the guidelines to overcome barriers, it is vital to show the consistency between Rogers' model and the TAM. In fact, all five of these parameters can be

reconducted to perceived ease of use or perceived usefulness. This comparison aims to strengthen the validity of the guidelines, which combine the barriers to adoption and diffusion of technologies into a unique set of guidelines.

First, *Compatibility* increases *Perceived Usefulness* because if the software is consistent with existing values, it can produce a higher output. *Compatibility* also increases *Perceived Ease of Use* because being consistent with past experiences makes software easier to master.

Second, *Complexity* is, by definition, a parameter that decreases the *Perceived Ease of Use*.

Third, *Observability* increases perceived usefulness. In TAM, it is linked to both *Results Demonstrability* and *Subjective Norm*, since it is defined as making the results visible to others.

Fourth, *Relative Advantage* is linked with both *Perceived Usefulness* and *Ease of Use*. Specific software can be more advantageous than another both in output quality and in figurative costs.

Last but not least, *Trialability* is linked with both *Perceived Usefulness* and *Ease of Use*. Breaking down software into smaller pieces can make it easier to learn (ease of use) and more productive, as users can focus on the functionalities that they need from the software.

In conclusion, all features presented by the DOI are consistent with the TAM. This analysis of the two models was fundamental for drafting the guidelines on barriers based on the literature, as it shows consistency between the two phases of adoption and diffusion of technology. Therefore, it is possible to combine the works of the two authors and merge them into a set of guidelines.

2.2.3 Guidelines for Barriers – Literature Review

In paragraph 1.3, the following research sub-question was raised:

> (1.1) How can the barriers of Enterprise Systems be overcome?

The response to this research sub-question is based on the literature review conducted above. Each guideline stems from the combination of the models by Rogers (2010) and Venkatesh and Davis (2000). Furthermore, these models are compared to the definitions of software usability by Kirakowski (1993) and the ISO (2011). This comparison is vital to ensure that the purpose of the guidelines is not only to accept and use ESs but also to increase their usability, which is the purpose of this thesis.

The first guideline introduced is centred around *Trialability* from Rogers (2010), which states that innovations should be experimented on a limited basis and is linked to the *Accessibility* and *Learnability* of the software. Indeed, ensuring high *Trialability* increases its perceived ease of use. In practice, this parameter translates into the first guideline: ESs should not force users to be familiar with all functionalities.

The second and sixth guidelines touch upon *Relative Advantage* from Rogers (2010) and, respectively, *Perceived Ease of Use* and *Perceived Usefulness* from Venkatesh and Davis (2000). Concretely, these two guidelines state that ESs should provide results in a more efficient (*Perceived Ease of Use*) and more effective way (*Perceived Usefulness*). Furthermore, these two guidelines can be reconnected to the definition of software usability by both Kirakowski (1993) and the ISO (2011). In practice, these guidelines mean that ESs, when compared with alternatives, need to be easier to operate and control (*Operability*) or better at assisting users in solving operational problems (*Helpfulness*).

The third and fourth guidelines are drawn from the aspects of *Compatibility* and *Complexity* mentioned by Rogers (2010). By definition, these are parts of the *Perceived Ease of Use* since high compatibility and low complexity entail that a software performs better in terms of *Learnability* and *Accessibility*. In practice, these

guidelines state that ESs should be compatible with existing websites or applications that serve similar purposes and that ESs should not be difficult to understand or use.

The fifth and seventh guidelines stem from the model of Venkatesh and Davis (2000). More specifically, from the category of *Cognitive Instrumental Processes*, which includes the aspects of *Job Relevance*, *Output Quality* and *Result Demonstrability*. In their work, the two authors underline that users need to be able to see *Job Relevance*, *Output Quality* and *Result Demonstrability*: these features increase *Perceived Usefulness*. More specifically, these factors contribute to increasing *Appropriateness Recognisability* as well as *Affect, Helpfulness* and *Controllability* of the ES. At the same time, their absence discourages users from using the software. To summarise these points, guidelines B005 and B007 state that ESs should be consistent with the tasks users have and provide visible results to users.

To summarise the analysis conducted above, the barriers to ESs can be overcome as schematised in Table 3 below.

Table 3. Barriers – Literature Review

Code	Perceived Ease of Use	Source
B001	The ES should not force users to be familiar with all their functionalities in order to achieve results.	*(International Organization for Standardization, 2011; Kirakowski, 1993; Rogers, 2010; Venkatesh & Davis, 2000)*
B002	The ES should provide results more efficiently compared to alternatives.	
B003	The ES should be consistent with existing websites or applications that serve their same purpose.	
B004	The ES should not be difficult to understand or use.	
Code	**Perceived Usefulness**	**Source**
B005	The ES should be consistent with the tasks that users have to perform in the company.	*(International Organization for Standardization, 2011; Kirakowski, 1993; Rogers, 2010; Venkatesh & Davis, 2000)*
B006	The ES should provide results more effectively compared to alternatives.	
B007	The ES should provide results that are visible to users.	

Before concluding the paragraph on barriers of ESs in the literature, it is important to stress the validity of these statements.

First, these seven guidelines are based on various sources of the literature, as visible in Table 3 above. Moreover, they were implemented during the redesign of the ES in the case study at AkzoNobel. When the redesign was completed, each statement was validated during six separate interviews.

Furthermore, besides the qualitative evaluation of the guidelines, a quantitative evaluation of the software usability is presented in paragraph 3.5, where the positive impact of the redesign is statistically proven.

2.3 Functionalities of ESs

This paragraph presents a literature review on the functionalities of ESs, which are the set of features and characteristics that increase the usability of ESs.

Since the scope of this thesis is to provide a set of guidelines to improve the usability of ESs for knowledge sharing and collaborative work. Hence, only functionalities that serve this purpose are considered.

The theory from the literature is presented in subparagraphs 2.3.1, 2.3.2 and 2.3.3. After that, an analysis of the literature is conducted in subparagraph 2.3.4, leading to the guidelines presented in Table 4.

2.3.1 Managing Knowledge

James March (1991) has mathematically proven that organisations perform suboptimally when they focus too much on either knowledge exploitation or exploration. In practice, this means that the aim of the information stored should be balanced between using at best pre-existing knowledge (exploitation) and discovering novel knowledge (exploration). His study was deemed as one of the most influential works on knowledge management (Wilden et al., 2018).

In their work, Gunadham and Thammakoranonta (2019) claim that it is important to store knowledge centrally. Moreover, Abdullah et al. (2005) argue that knowledge-sharing is more effective when it is independent of time and space, which is consistent with the idea of a central deposit. In the same study, Abdullah et al. (2005) also suggest that the knowledge stored should not be redundant and that it should have a clear recipient.

In addition to functionalities connected to storing knowledge, retrieving said information is also another relevant aspect connected to managing knowledge. Predictably, Joachims (2002) indicates that users expect the most relevant results to be on top when searching for information. Moreover, when it comes to researching for documents the location of which is not known, Gunadham and Thammakoranonta (2019) claim that users should be able to search not only by title but also by content.

After the search for a document is carried out, Hearst (2011, p. 131) stresses the importance of offering users a preview of the results, similarly to how some web engines operate. Allowing users to glimpse through search results before pressing on them is vital to limiting errors. In fact, searches are generally secondary activities that users carry out while focusing on other tasks: this makes users prone to more errors (Hearst, 2011).

2.3.2 Social Collaboration

Networks and social collaboration cover an important role in the successful management of knowledge. As a matter of fact, stronger relationships have a more positive effect on the transfer of expertise compared to weaker ones (Hansen, 1999). Furthermore, Swan and Scarbrough (2005) showed the importance of network formation and coordination for knowledge management, and Choi et al. (2018) confirmed that social interactions positively affect knowledge management systems.

A more practical perspective on social collaboration was offered by Gunadham and Thammakoranonta (2019). They propose to improve ESs by enabling users to create a personal profile, consult other profiles and contact other users. These features would allow users to create both weak and strong ties over time, and could also have a positive effect on knowledge management as described by Choi et al. (2018).

2.3.3 Interface

The literature has discussed the importance of software modularity for decades, and its definitions vary widely (Fodor, 1983; Liu et al., 2020; Pil & Cohen, 2006; Sanchez & Mahoney, 1996; Seok, 2006). For the purposes of this thesis, modularity is defined as dividing vast and complex pieces of information into several smaller bits.

This definition was selected because this thesis focuses on knowledge sharing via ESs. Therefore, modularity has a dual role: organising and presenting information. Indeed, with companies becoming more intricate and accumulating further knowledge, it is essential to categorise and break down information into smaller bits (Sanchez & Mahoney, 1996). In terms of ESs, the division of information into smaller bits can be implemented with a modular interface. In practice, this translates into dividing each

interface into several sections that are both mutually exclusive and collectively comprehensive, so that all content is presented without repetitions.

Another important element of software design is known as the vanilla implementation, which is essentially the implementation of software with no possibilities of customisations. The importance of this idea is supported by Burns et al. (2006), who proved the superiority of the vanilla implementation of software in terms of data processing properties and technical efficiency. Along those same lines, Hearst (2011) suggests keeping user interfaces as simple as possible and with minimal customisations.

The last element analysed for what concerns the user interface is based on a study by Cooke (2008), who tracked eye-movement and realised that the ideal placing of the most important navigation elements is the top-left part of a screen.

2.3.4 Guidelines for Functionalities – Literature Review

In paragraph 1.3, the following research sub-question was raised:

> (1.2) What are the functionalities that Enterprise Systems should have?

The response to this research subquestion is based on an analysis of the literature review conducted above. Each guideline stems from one of the sources presented in the previous paragraphs and is then compared to the definitions of software usability by Kirakowski (1993) and the ISO (2011). This comparison is vital to ensure that the purpose of the guidelines is to increase their usability, which is the purpose of this thesis. The following lines analyse the literature review and lead to the guidelines that are schematised in Table 4.

The first group of guidelines concern the deposit function, which is where knowledge is stored in the ES. For that, guideline F001 is based on one of the most influential works on knowledge management (Wilden et al., 2018), carried out by James March.

In his work, March (1991) proved that companies perform best if they balance knowledge exploitation and exploration. By definition, achieving this balance means increasing *Helpfulness* and *Appropriateness Recognisability* of the ES.

In addition to the type of knowledge stored, further works have analysed where and how said knowledge should be stored. Based on the works of Abdullah et al. (2005) and Gunadham and Thammakoranonta (2019), guidelines F002 and F003 state that knowledge should be stored centrally and that knowledge without a clear recipient should be removed. Concretely, these guidelines state that users of ESs should store information on the central drive as opposed to personal drives and that each document stored on an ES should have a clear recipient. In terms of software usability, these guidelines aim to make the software more efficient, more effective and easier to navigate since documents stored in a central location are easier to retrieve than if they are stored in separate and widespread locations. More specifically, the parameters targeted are *Efficiency*, *Helpfulness*, *Learnability* and *Accessibility*. These observations are further investigated in subparagraph 3.2.1, which discusses the causes and consequences of lack of maintenance.

The second group of guidelines targets another relevant aspect of managing knowledge within ESs: the search function.

The fourth guideline is based on the work of Gunadham and Thammakoranonta (2019) and Joachims (2002). These authors claim that search results should display the most relevant knowledge on top, consistently with the most used search engines. This measure increases the *Compatibility* of the ES with popular search engines, thereby increasing its *Accessibility* and *Learnability*.

Besides this, the fifth and sixth guidelines extend the capabilities of the search functions by enabling search via documents' content and by adding previews to prevent errors. These two guidelines based on the works of Gunadham and Thammakoranonta (2019) and Hearst (2011) aim to make the ES more helpful, easier to learn and less prone to mistakes. Therefore, the parameters targeted are *Controllability, Helpfulness, Learnability* and *User Error Protection*. Indirectly, these measures increase *Affect* and *Efficiency* by ensuring a more effective search function and limiting the time that users spend searching for documents.

The third group of guidelines is grounded on the theories by Choi et al. (2018), Hansen (1999) and Swan and Scarbrough (2005), who highlight the importance of social collaboration in the field of knowledge management. Within ESs, social collaboration is translated into publicly consultable users' profiles. The research by Gunadham and Thammakoranonta (2019) further expands on this by claiming that users should be able to consult other profiles and contact each other. Altogether, these measures target *Affect*, *Accessibility* and *Learnability* by fostering a more pleasing usage of the software for users while also ensuring that they can learn from each other.

Last but not least, the fourth group of guidelines focuses on the interface of ESs. By definition, these guidelines aim to improve *User Interface Aesthetics*.

Starting with the work of Hearst (2011) and Sanchez and Mahoney (1996), the first guideline claims that interfaces should be divided into sections, to ensure that information is divided into clear and simple clusters.

Along the lines of simplicity and vanilla implementation, the work of Burns et al. (2006) led to guidelines F011, F012 and F013. These measures target *Accessibility* and *Learnability* by proposing simple interfaces with minimal customisations that are also standardised across different parts of the ES.

The last guideline aims to increase the *Operability* of the software, and it is based upon a study by Cooke (2008), who suggested that the most relevant elements should be on the top-left part of the screen.

Table 4 summarises the analysis above and presents the functional requirements.

Table 4. Functionalities – Literature Review

Code	Deposit	Source
F001	The aim of knowledge stored should be balanced between exploitation and exploration.	*(March, 1991; Wilden et al., 2018)*
F002	Knowledge should be stored centrally.	*(Abdullah et al., 2005; Gunadham & Thammakoranonta, 2019)*
F003	Knowledge that is redundant or does not have a clear recipient should be removed.	*(Abdullah et al., 2005; Gunadham & Thammakoranonta, 2019)*

Code	Search	Source
F004	Relevant knowledge should be on top of the page.	*(Gunadham & Thammakoranonta, 2019; Joachims, 2002)*
F005	Knowledge should be accessible by searching for document title or document content.	*(Gunadham & Thammakoranonta, 2019)*
F006	Search queries should include a preview of results to prevent errors.	*(Hearst, 2011)*
Code	**Social Collaboration**	**Source**
F007	Users should have their own profile that includes a contact and information about their role.	*(Choi et al., 2018; Gunadham & Thammakoranonta, 2019; Hansen, 1999; Swan & Scarbrough, 2005)*
F008	Users should be able to learn about other users' profiles.	*(Choi et al., 2018; Gunadham & Thammakoranonta, 2019; Hansen, 1999; Swan & Scarbrough, 2005)*
F009	Users should be able to contact other users.	*(Choi et al., 2018; Hansen, 1999; Swan & Scarbrough, 2005)*
Code	**Interface**	**Source**
F010	The interface should be divided into sections.	*(Hearst, 2011; Sanchez & Mahoney, 1996)*
F011	The interface should be kept as simple as possible.	*(Burns et al., 2006)*
F012	The interface should have minimal customisation.	*(Burns et al., 2006)*
F013	The interface should be standardised across different parts of the ES.	*(Burns et al., 2006)*
F014	The most important elements should be on the top-left part of the graphic user interface.	*(Cooke, 2008)*

Before concluding the paragraph on functionalities of ESs in the literature, it is important to stress the validity of these statements.

First, these fourteen guidelines are based on various sources of the literature, as visible in Table 4 above. Moreover, they were implemented during the redesign of the ES in the case study at AkzoNobel. When the redesign was completed, each statement was validated during six separate interviews.

Furthermore, besides the qualitative evaluation of the guidelines, a quantitative evaluation of the software usability is present in paragraph 3.5, where the positive impact of the redesign is statistically proven.

3. Case Study

The case study took place in the planning department of Decorative Coatings of AkzoNobel (AN), located in Sassenheim. The role of the department is to connect demand to production, ensuring that materials arrive on time and that coatings are produced on schedule. This department is responsible for all sites located in the three European hubs of AN, which span across Belgium, France, Italy, Poland, Spain and many other sites.

Although events such as the unfolding COVID-19 crisis may drastically change the conditions of work, the procedures within the department are generally highly standardised. As a matter of fact, all regional hubs use the same tools in their daily tasks and follow the same procedures. Hence, the type of organisation can be described as knowledge-routinised (Blackler, 1995) and the type of knowledge involved is objectified (Spender, 1996).

A few years before the case study, the department introduced Microsoft SharePoint as a virtual space to store and share three types of files:

- **operational files** for their daily, weekly or monthly tasks;
- **guides** about best practices;
- **leaflets** with information about the company or the department.

In the words of the Director of Global Supply Chain Planning and Special Projects, this software was meant to be "the departments' knowledge bank". It was supposed to host all operational documents, standardised procedures and leaflets about AN's culture and values, as well as information about each role in the department.

Initially, the software was both effective and efficient. The files were easy to find, updated and structured according to the three regional hubs of the company.

However, the company recently restructured its regional hubs and increased their number to five. Furthermore, the employees responsible for maintaining the software had moved to other departments or left AN. Unfortunately, no replacement personnel

was appointed to substitute them and redesign the virtual space according to the new structure.

This combination of events created several complications as no one was responsible for or knew how to update the structure of the virtual space. Over time, this void created several barriers to the usage of the ES, hindering the productivity and effectiveness of employees. As a result, employees now often relied on colleagues more than on the software, and the virtual workspace had become disorganised, cluttered and obsolete.

In this context, the project started by defining the needs of users. These were immediately translated into guidelines for the restructuring of the ES. In parallel, a survey was sent to the department to evaluate the usability of the ES prior to the project. The outcomes of the interviews are discussed in paragraphs 3.2 and 3.3, where research sub-questions 1.1 and 1.2 are responded.

Then, the ES was rebuilt based on these guidelines as well as those drawn from the literature. During this phase, the help of experts from AN was crucial to redesign the more technical aspects of the ES. This aspect is analysed in paragraph 3.4.

After the redesign project, the guidelines implemented were validated via a second round of interviews. Furthermore, the usability of the ES was measured again to evaluate the impact of the redesign. The results and their statistical significance are discussed in paragraph 3.5.

3.1 Methodology of the Case Study

The case study included two independent series of interviews and two surveys, aiming to achieve a comprehensive and thorough analysis with qualitative and quantitative elements.

The first round of interviews took place before the redesign of the ES. Its objectives were to identify the main barriers to usage of the software and the most requested features for the ES. These requests from the users were translated into guidelines and implemented during the redesign of the ES.

In order to understand the needs of the department, users were divided into the following categories: high-level executives, middle-level managers, and planners. These focus groups are representative of the department because they are mutually exclusive and collectively exhaustive, spanning vertically across the whole department. The following paragraphs explain the rationale behind this division in further detail.

The first focus group was **high-level executives**. Given the low number of stakeholders in this category as well as the technical difficulties in scheduling meetings with senior executives, only one person was interviewed from this category: the Director of Global Supply Chain Planning and Special Projects. He contributed with qualitative information on how to align the software with the vision of the company.

The second focus group was the **middle-level managers**. Middle-level managers have been in the company for at least two years and have an overview of the daily operations of the regional hub that they coordinate. Moreover, several of them participated in the first introduction of the ES or worked on continuous improvement projects on it. These elements make them knowledgeable contributors since they can act as a bridge between the technical features of the software and its usage in practice. From this focus group, all five managers were interviewed to have an overview that was as comprehensive as possible.

The third focus group was the **planners**. This focus group includes the daily users of SharePoint, who contributed with information about barriers and features of the ES. The population of planners is the biggest one out of the three focus groups, and it includes material and production planners of all the AkzoNobel production plants in

Europe. For the purposes of this thesis, this formal distinction was not considered relevant since both roles use the ES in the same way and need the same features from it. Nevertheless, the distinction was taken into consideration when selecting interviewees for both rounds to ensure a holistic perspective on the redesign. Hence, two planners were interviewed from each of the five regional hubs, summing up to a total of ten interviewees.

The questions asked during the first round of interviews can be found in Appendix A, B and C.

After the interviews, the SUMI questionnaire was sent to the whole department to evaluate the usability before the redesign. The population selected for the SUMI questionnaire included every user of the ES with no distinctions. Out of 115 employees of the department, a total of 27 responses were received. These were deemed statistically significant because of the low standard deviation of the responses. More information on the statistical significance of the SUMI questionnaires can be found in paragraph 3.5.

After the redesign, the second round of interviews aimed to provide in-depth insights into the redesign and validate the findings. For that, interviewees were asked to validate and confirm every single guideline. Moreover, interviewees were asked to add or remove other elements if they thought that something was missing or if they disagreed with any of the guidelines.

This round of interviews included seven participants: one middle-level manager and six planners, with at least one representative for each of the five regional hubs. All seven interviewees were involved in the redesign project and had participated in the first round of interviews. Furthermore, the six planners had gathered feedback on the redesign from other planners of their regional hubs.

The questions and more information on the procedure of this round of interviews can be found in Appendix E.

The final step of the research was a second SUMI questionnaire, which aimed to measure the ES's usability after its redesign. The respondents to the survey were selected from all regional hubs of the company, involving two middle-level managers and 12 planners. The sample is representative of the overall population of users since

it maintained a balanced ratio of managers/users, included a sufficient absolute number of participants and spanned across all regional hubs. Moreover, the responses present a low standard deviation, proving an overall agreement between respondents. More information on the statistical significance of the SUMI questionnaires can be found in paragraph 3.5.

Table 5 below summarises the number of people interviewed from each focus group during both rounds of interviews.

Table 5. Overview of Participants of the Case Study

Focus group	# of people interviewed – Interview 1	# of people interviewed – Interview 2
High-level executives	1	0
Middle-level managers	5	1
Planners	10	6

In conclusion, the methodology used combined quantitative and qualitative approaches. These elements ensure that the study is comprehensive, thorough and grounded on data. The quantitative elements strengthen the claims and provide an analytical dimension to the findings. The qualitative aspects, on the other hand, make it possible to validate the results and dig deeper than it can be done via a survey.

3.2 Barriers of ESs

This paragraph details how ESs should include overcoming barriers to their usage.

These findings have all been validated during the second round of interviews, which took place after the redesign. During the interviews, six planners and one manager were asked to reflect on the findings and confirm their validity. The questions asked during the interviews can be found in Appendix E.

3.2.1 Lack of Maintenance

Although the ES had been introduced just two years before the case study, the absence of a control plan hindered the productivity and effectiveness of employees. Complications included difficulties in finding updated documents or inability to tell which version of the same document included the most updated and correct information. These difficulties pushed the employees who tried to limit the usage of the ES and looked for alternative ways of gathering information.

During the case study, maintenance was broken down into two aspects: user knowledge and content ownership. These aspects are explained below.

User knowledge deals with ensuring that employees have a basic understanding of the ES and the logic behind its structure. A successful user support section should enable all employees to make use of the ES in a way that is functional for them. As mentioned by some respondents to the SUMI, users need to be able to use some parts of the ES effectively for their tasks; they do not need to be able to use every function of the software. Two solutions suggested by respondents were a “Frequently asked questions” (FAQ) section, plus manuals and tutorials on how to access and use specific parts of the ES. Following this strategy should be successful in the short term, as highlighted in the interviews. For the long run, it is also suggested to divide users based on their expertise and to inform everyone of this structure. By doing so, users should always know whom they can approach for questions related to the ES. Furthermore, providing regular user training is suggested to refresh the knowledge of all users and increase awareness of the functionalities of the ES.

Content ownership entails allocating responsibility for keeping the ES updated. Indeed, one of the most recurring problems of users was that they sometimes found different versions of the same document with conflicting information. Part of this problem is tackled by subparagraph 3.2.2, yet maintenance also covers an important role here. Some respondents expressed that several users create documents, store them in an inappropriate folder and then never update it.

The proposed solutions work on two levels.

First, experienced employees should be publicly appointed to update the pages of the ES pertaining to their responsibilities. This measure aims to prevent the vast majority of documents from becoming outdated and guarantees that someone in the company knows where all documents are. Moreover, publishing the names of the employees accountable for updating the pages of the ES also ensures that all employees know whom they should approach when they need to find a certain document.

Second, updates should happen at a regular frequency, which should be established based on the type of content. As a matter of fact, a document may go unchecked during the continuous maintenance mentioned above. This measure aims to ensure that all documents are updated even if designated employees did not update them. However, not all documents need to be checked with the same frequency, which is why no fixed time frame was proposed for maintenance measures.

3.2.2 Difficulty in Finding Documents

During the interviews, users expressed that they were often discouraged from using the software due to the difficulty in finding documents. Moreover, 12 users mention accessing documents as the point that needs to be improved the most. They linked their difficulty to the widespread tendency of connecting users to new content via direct links. This habit somehow hinders users from having an overview of the structure of the ES, which is a factor that was mentioned consistently by respondents to the SUMI.

The existence of conflicting information was linked to two causes: the lack of a central storage unit for documents and the absence of an interconnected overview. Indeed, when users struggled to find documents, they created their personalised copies.

Subsequently, given the lack of a central location unit, they stored those documents in the wrong place (personal folders). The solutions proposed to tackle this problem operate on two levels. First, users should have access to a thorough and interconnected overview of all documents, which includes shortcuts to the most used documents. Second, the situation can be avoided in the first place by implementing a stricter authorisation system that only allows the appropriate users to create personal folders.

3.2.3 Guidelines for Barriers – Case Study

In paragraph 1.3, the following research sub-question was raised:

> (1.1) What are the barriers of ESs?

The response to this sub-question is based on the first round of interviews, during which the guidelines were drafted. Moreover, at the end of the redesign project, all guidelines were validated individually via a second round of interviews.

Further details on the results of the case study were presented in subparagraphs 3.2.1 and 3.2.2.

Table 6 below summarises how the barriers of ESs can be overcome.

Table 6. Barriers - Case Study

Code	Users' Knowledge
B008	The ES should include a FAQ section and keep it updated.
B009	The ES should include manuals and tutorials that explain how to use the software.
B010	Divide users based on their expertise and make this structure public so that everyone knows who to approach with questions.
B011	Regular training on the functionalities of the ES and the rationale behind its structure should be organised.
Code	**Content Ownership**
B012	Every part of the ES should have a publicly known owner who is accountable for keeping that part updated.

B013	Regular time windows for updating every part of the ES should be established.
Code	**Difficulties in Finding Documents**
B014	The ES should not store conflicting copies of documents.
B015	Include different versions of the same document.
B016	The ES should store documents in a centralised location accessible to everyone.
B017	The ES should include shortcuts to facilitate moving across their different parts.
B018	Only a limited number of expert users should have the authorisation to create folders.

3.3 Functionalities of ESs

This paragraph details the functionalities that ESs should include in order to overcome barriers to their usage and be effective.

These findings have all been validated during the second round of interviews, which took place after the redesign. During the interviews, six planners and one manager were asked to reflect on the findings and confirm their validity. The questions asked during the interviews can be found in Appendix E.

3.3.1 One-Click and One-Screen System

One problem mentioned by five SUMI respondents and several interviewees was the low speed of the software, which discouraged them from using the ES. The root cause analysis revealed that the number of clicks heavily influenced time to the destination since the software loads a new page every time users click on a link. Therefore, the search process gets very time consuming if users press on subsequent links or if they click on the wrong link and have to reload multiple pages in their history.

A system with one single click proposes to solve problems connected to the speed of the software by minimising the number of pages that have to be loaded or refreshed if users press on a wrong link. After the redesign, the one-click system was consistently mentioned by users as the most important innovation. Its impact is visible in the *Efficiency*, which increased from an insufficient value of 47.93 to a highly satisfactory 59.07. Furthermore, users expressed that the new system helps significantly in preventing errors: “There is no need to go back and keep trying to find different files, it is comfortable to move around folders”.

In addition to the One-Click System, throughout the interviews users expressed their willingness to have a simple ES, with few and condensed elements. For that purpose, it is recommended to condense all content in one single screen and to limit actions such as scrolling both vertically and horizontally.

In the same way as the One-Click System, the One-Screen System tackles the low speed of the software by condensing all the content needed by users in one single page.

3.3.2 Search

In addition to the difficulties in finding the right folders, users mentioned that they struggled to find documents when searching for them due to the faulty search system.

Initially, the ES included a search function that was not limited to the department but spanned throughout the whole enterprise. Since AN is a large multinational corporation, searches could show tens of thousands of results and discourage users from using the search box. On top of that, it was not possible to see previews of the results, which hindered an effective search and contributed to users pressing on the wrong results. Limiting the search to more relevant results and enabling previews were highly requested functionalities during the interviews, and they were greatly appreciated once they were put in practice.

3.3.3 Standardisation

Standardisation covers a fundamental role for interdepartmental and inter-functional exchanges of information. Having the same interface in different parts of the ES increases the *Learnability* and *Accessibility* of the software. It also enables users from different functions and departments to use the same software, which facilitates exchanges of information and streamlines job rotation.

In addition to standardising the interface, users highlighted the importance of standardising the structure where documents get stored. In practice, this means that different geographical locations should present identical or highly similar folders where to store the documents. During the interviews, users expressed that standardisation facilitates the search for documents, reduces the time that it takes for them to retrieve information, and limits the mistakes committed in the process.

Furthermore, one of the final goals of standardisation should be to facilitate connecting every part of the ES. In this way, users should have access to an overview of the whole ES, which they could consult to have a full picture of the knowledge spread across different functions and departments.

3.3.4 Guidelines for Functionalities – Case Study

In paragraph 1.3, the following research sub-question was raised:

> (1.1) What are the functionalities that ESs should have?

The response to this sub-question is based on the first round of interviews, during which the guidelines were drafted. Moreover, at the end of the redesign project, all guidelines were validated individually via a second round of interviews.

Further details on the results of the case study were presented in subparagraphs 3.3.1, 3.3.2 and 3.3.3.

Table 7 below summarises the beneficial features of ESs.

Table 7. Functionalities – Case Study

Code	One-Click System
F015	The ES should offer, whenever possible, the possibility of finding content with just one click.
F016	If a One-Click System is not feasible, the ES should try to limit the number of clicks to the destination.
Code	**One-Screen System**
F017	The ES should present all content in one screen.
F018	The interface of the ES should minimise the need to scroll vertically or horizontally.
Code	**Search**
F019	The ES should limit the search results to relevant files.
Code	**Standardisation**
F020	The ES should present, whenever possible, the same interface on every page.
F021	The ES should present, whenever possible, the same structure for document storage on every page.
F022	The ES should integrate all parts into a comprehensive overview that is available for users to consult.

3.4 Further Findings

In addition to the findings specifically connected to the redesign of the ES, it is important to mention the importance of project management. Indeed, the redesign of an ES is in itself a project, and in order for it to be successful, it needs the public and explicit approval from top management, which should also be involved directly. These claims are vastly documented in the literature (Al-Fawaz et al., 2008; Al-Mashari et al., 2003; Bingi et al., 1999; Clemons, 1998; Esteves & Pastor-Collado, 2002; Fui-Hoon Nah et al., 2001; Somers & Nelson, 2001; Umar et al., 2018). Furthermore, Remus (2006) also suggested that project champions should be senior managers of the company as they are decisive for the success of ES implementation.

During the case study, it has been fundamental to have access to the right know-how across the different departments of the company. Top management and the project champion acted as a bridge by connecting with the employees that had the competences and authorisations to implement the redesign from a technical standpoint. Without their know-how, it would not have been possible to complete the project in time and realise the design. Therefore, involving top management in the project was crucial to its success.

Moreover, the explicit support from top management and the presence of a senior manager as project champion were of vital importance during the phase of selection of the design to be implemented. Their explicit approval was necessary to give the project the final green light for implementation during the decision-making meetings.

3.5 SUMI Questionnaires

This paragraph will present the results of the SUMI questionnaires and conclude the chapter on the findings of the case study.

Before delving into the results of the questionnaire, it is necessary to introduce some statistical information on the SUMI scales.

The SUMI scales are statistically adjusted so that the mean of each parameter is 50, and the standard deviation is 10. Therefore, a mean value lower than 50 entails that users find the performance of the software to be unsatisfactory and a standard deviation of 10 shows that users are consistent and agree on the responses.

As a reminder to the reader, the definitions of the parameters analysed by the SUMI are reported in Table 8.

Table 8. Definitions of SUMI Parameters (Kirakowski, 1993)

Parameter	Definition
Affect	The respondents' feeling that the ES is stimulating and pleasing to use.
Controllability	The feeling that the ES is responding consistently with the expectations of the user.
Efficiency	The respondents' feeling that the ES is enabling them to work quickly, effectively and simply.
Helpfulness	The degree to which the ES assists users in solving operational problems.
Learnability	How straightforward it is for users to become familiar with the ES.

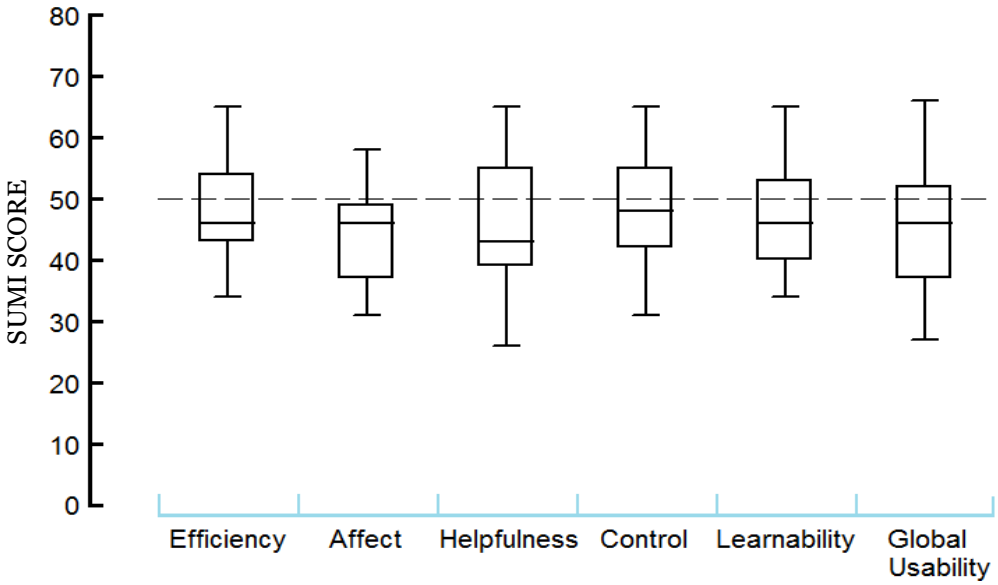
3.5.1 First Survey Results

Table 9 and Figure 2 give an overview of the analytical results of the first survey, which took place before the redesign of the ES.

Table 9. SUMI Results – First Questionnaire

	Mean	St Dev	Median
Global	45.19	9.21	46.0
Efficiency	47.93	8.44	46.0
Affect	44.33	8.03	46.0
Helpfulness	45.74	10.27	43.0
Controlability	47.93	8.84	48.0
Learnability	46.67	8.49	46.0

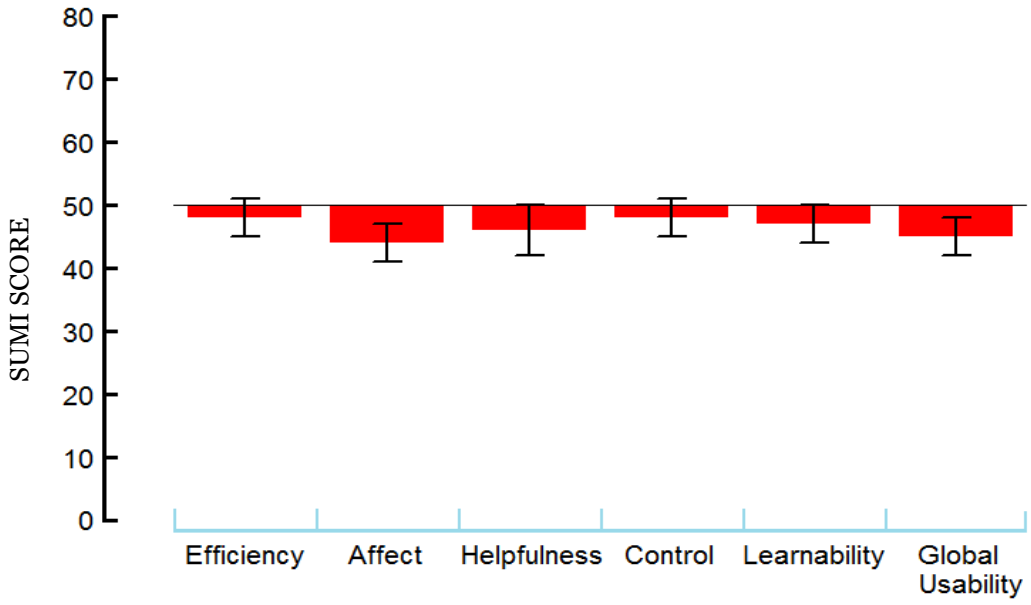
Figure 2. SUMI Median Boxplots – First Questionnaire



The first SUMI proved that users found the ES unsatisfactory on all levels since all means and medians are below 50, which equals to a sufficient score. The most alarming variable was the *Affect*, with a score of 44.33: this proved that the ES did not stimulate users at all and was unpleasant to use. The low standard deviation of this parameter (8.03) also showed that the users strongly agreed on this.

The means with 95% confidence intervals provide further insights. The graph is reported and commented upon below.

Figure 3. SUMI Means with 95% Confidence Intervals – First Questionnaire



The low standard deviations for all variables already suggested that users agreed that the ES was unsatisfactory. Figure 3 validates these insights and shows how almost the entire population of users agrees that the system is inadequate on all levels. More specifically, the staples show where the mean would fall 95% of the time if we repeated the survey with the same sample size and population, and under the same conditions.

In conclusion, users agree that the ES before the redesign:

- did not enable them to work quickly, effectively and simply (*Efficiency*);
- did not stimulate them at all and was unpleasant to use (*Affect*);
- did not respond consistently with their expectations (*Controllability*);
- did not help them to solve operational problems (*Helpfulness*);
- was difficult to familiarise with (*Learnability*);
- did not give a general feeling of satisfaction (*Global*).

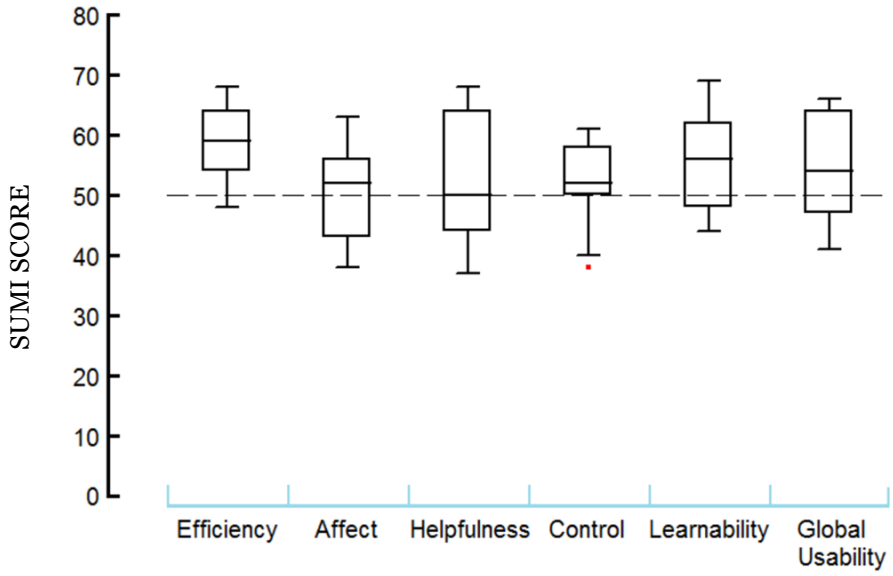
3.5.2 Second Survey Results

Table 10 and Figure 4 give an overview of the analytical results of the second survey, which took place after the redesign of the ES.

Table 10. SUMI Results – Second Questionnaire

	Mean	St Dev	Median
Global	54.07	9.06	54.5
Efficiency	59.07	6.39	59.0
Affect	50.93	7.83	52.5
Helpfulness	52.64	10.49	50.0
Controlability	52.57	7.08	52.0
Learnability	55.79	8.40	56.0

Figure 4. SUMI Median Boxplots – Second Questionnaire

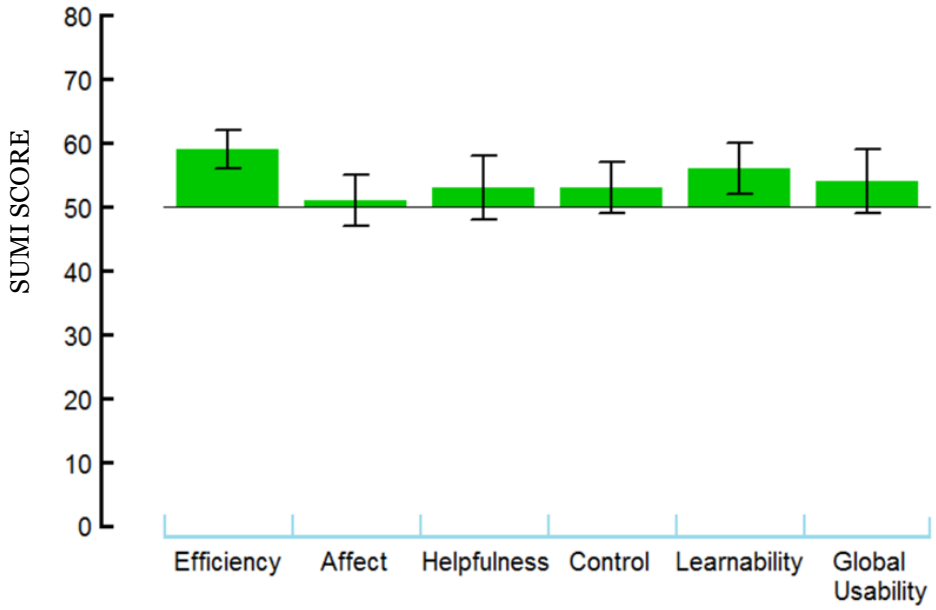


The second SUMI proved that users found the redesigned ES satisfactory in terms of *Affect* and *Helpfulness*, good in the fields of *Control*, *Learnability* and *Global Usability* and excellent in terms of *Efficiency*. The standard deviation is consistently and significantly lower than 10 in *Efficiency* (which has the lowest value of 6.39), *Affect*, *Control*, *Learnability* and *Global Usability*, while it is slightly above the mean of 10 in *Helpfulness*. There is only one potential outlier which is visible as a red dot under the boxplot of *Controllability*. This outlier can be ignored because it is the only outlier in the whole observed population, and the standard deviation of *Controllability*

is very low (7.08). A potential explanation of the outlier is that this specific respondent is not yet familiar with the redesigned ES.

In addition to the boxplot, Figure 5 below shows the means with 95% confidence intervals, providing further insights.

Figure 5. SUMI Means with 95% Confidence Intervals – Second Questionnaire



The low standard deviations for all variables already suggested that users agreed that the ES was satisfactory. Similarly to what happened with the first survey, the means with 95% confidence intervals visible in Figure 5 validate these insights and show how almost the entire population of users agrees that the system has improved on all levels.

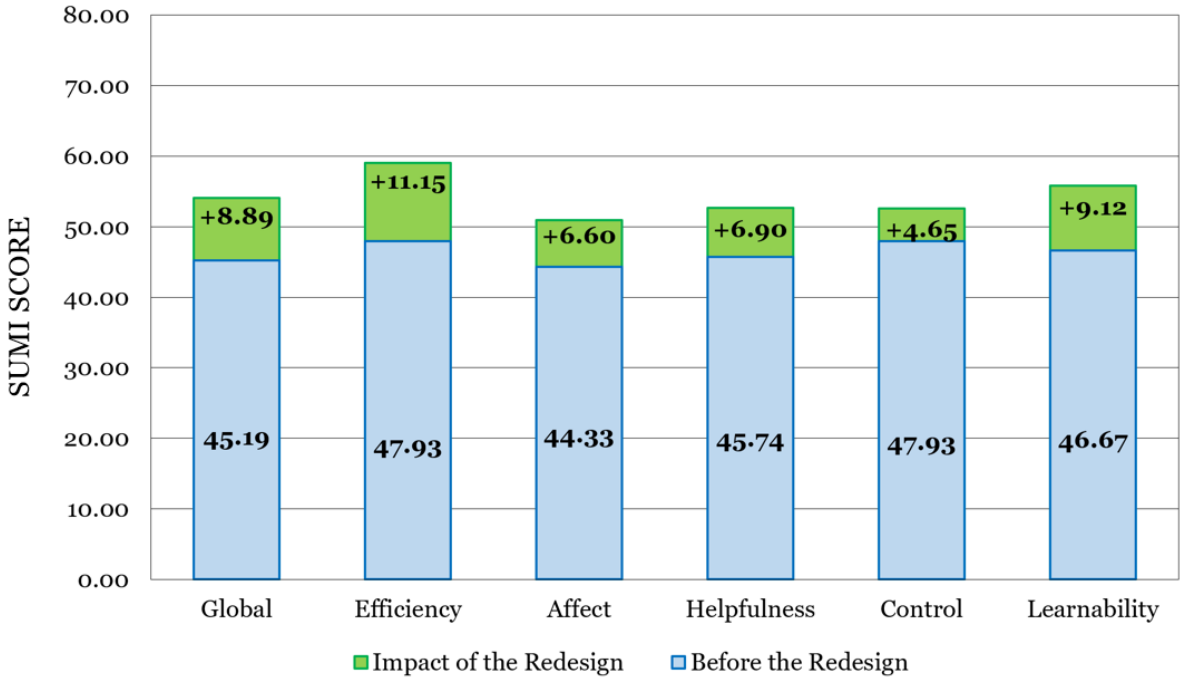
In conclusion, after the redesign, users agree that the ES:

- enables them to work quickly, effectively and simply (*Efficiency*);
- stimulates them and is pleasant to use (*Affect*);
- responds consistently with their expectations (*Controllability*);
- helps them to solve operational problems (*Helpfulness*);
- is easy to familiarise with (*Learnability*);
- gives a general feeling of satisfaction (*Global*).

3.5.3 Assessment of the Impact of the Redesign

As expressed in subparagraph 3.5.1, the usability of the ES was unsatisfactory on all levels. The implementation of the measures outlined in paragraphs 3.2 and 3.3 had a significant impact on the usability of the ES. Figure 6 below summarises the impact of the redesign in each category.

Figure 6. Usability After the Redesign



The data tells us that *Efficiency* increased by 23% and that both *Global* and *Learnability* improved by 20%. The interviews and the free-text responses confirmed the quantitative findings, with several users stressing upon the efficiency and user-friendliness of the redesigned ES. More specifically, the one-click system described in subparagraph 3.3.1 was the most appreciated measure since it increased the speed of the ES significantly. It should be noted that this finding is consistent with the fact that *Efficiency* is the parameter that increased the most.

In addition to these fields, the measures implemented contributed to making the software perform better also in *Affect* (+15%), *Helpfulness* (+15%) and *Control* (+10%). As a reminder to the reader, these three parameters evaluate the general feeling of satisfaction while using the ES (*Affect*), whether the ES helps users with their

tasks (*Helpfulness*), and the consistency of the responses of the ES with the expectations of users (*Control*). These fields would require users to get used to the new system, and it is therefore arguable that the improvement has been minor because of the timeline of the second survey, which took place not long after the redesign. Consistently with these claims, the interviews showed positive remarks in these fields for the near future and concrete concerns about the long run. Examples of these include: “I am concerned about what happens when a new file is added? Or a new folder? How is that maintained?”; “[the part that needs the most improvement is] keeping the structure and content up-to-date.”.

By contrast, *Efficiency*, *Learnability* and *Global* performance are more immediate to evaluate, and that is why these fields have seen their values skyrocket. This claim is based on the free-text responses to the survey, with five users claiming that the new structure was the best improvement of the redesign, as it is “better and easier to navigate”, “quicker, more automatic” and “clearly user friendly”.

3.5.4 Statistical Significance

To give a robust statistical significance to the findings and prove that the differences are not based on chance, unpaired t-tests were carried out. Unpaired tests were selected because the respondents to the two questionnaires were not identical.

The test had the following hypothesis:

$$H_0: \mu_1 = \mu_2$$

$$H_1: \mu_1 \neq \mu_2$$

The results of the t-test provide the following p-values.

Table 11. P-values of the SUMI New Scores

Parameter	Mean Before the Redesign	Mean After the Redesign	P-value
Global	45.19	54.07	0.0054
Efficiency	47.93	59.07	0.0001
Helpfulness	44.33	50.93	0.0497
Controllability	45.74	52.64	0.04*
Learnability	47.93	52.57	0.0022
Affect	46.67	55.79	0.0161

All variables have a p-value inferior to 0.05, which is the standard value to claim statistical significance. However, the *Controllability* only reaches statistical significance if we remove the outlier from the calculations of the t-test (with the outlier, its p-value is around 0.0974). The outlier is visible in Figure 4 as a red dot, and subparagraph 3.5.2 already explains that it can be ignored because of the low standard deviation of *Controllability* (7.08). In addition to the quantitative analysis, the interviews outlined that the redesigned software is "very clearly designed to be user friendly and respond to the needs of the users". Therefore, in light of statistical and qualitative elements, the outlier was not considered during the calculations.

In conclusion, we can refuse H_0 and accept H_1: the means of all values are different, and this is not due to chance.

4. Conclusion

This chapter presents the conclusions of this thesis and analyses the guidelines, responding to the research question.

Paragraphs 4.1 and 4.2 analyse, respectively, the guidelines on barriers and functionalities presented by the literature review and the case study. More specifically, these analyses aim to show the consistency between the guidelines from the literature and the case study.

Then, paragraph 4.3 describes the impact of the redesign project and the guidelines for AkzoNobel.

The following two paragraphs outline the limitations and contribution of this thesis.

Lastly, paragraph 4.6 suggests possible directions for further research.

4.1 Analysis of Guidelines – Barriers

The following subparagraphs analyse the guidelines proposed by this thesis. For that, each guideline from the case study is analysed and linked to those from the literature review.

As a reminder to the reader, the guidelines from the literature are presented in Table 12.

Table 12. Guidelines on Barriers – Literature Review

Perceived Ease of Use	
B001	The ES should not force users to be familiar with all their functionalities in order to achieve results.
B002	The ES should provide results more efficiently compared to alternatives.
B003	The ES should be compatible with existing websites or applications that serve their purpose.
B004	The ES should not be difficult to understand or use.

Perceived Usefulness	
B005	The ES should be consistent with the tasks that users have to perform in the company.
B006	The ES should provide results more effectively compared to alternatives.
B007	The ES should provide results that are visible to users.

4.1.1 Users' Knowledge

The section on users' knowledge proposes solutions to ensure that users can learn how to utilise the ES. The guidelines are reported below in Table 13 as a reminder to the reader.

Table 13. Guidelines – Users' Knowledge

Users' Knowledge	
B008	The ES should include a FAQ section and keep it updated.
B009	The ES should include manuals and tutorials that explain how to use the software.
B010	Divide users based on their expertise and make this structure public so that everyone knows who to approach with questions.
B011	Regular training on the functionalities of the ES and the rationale behind its structure should be organised.

The set of guidelines on users' knowledge acts on four different levels: FAQ section (B008), manuals and tutorials (B009), experienced users (B010) and training (B011). These means have different unique end goals but are all integrated to ensure that the ES is not difficult to use (B004).

Manuals and tutorials give users a deep understanding of the functionalities, which should enable users to get results from the ES in a more efficient (B002) and effective (B006) way.

The FAQ section aims at quickly tackling a specific need of a single user. Since not all users should know all functionalities of the ES (B001), it is vital to give them tools to achieve specific results.

In addition to this, the presence of a FAQ section should increase the compatibility of the ES with existing websites and applications (B003), since the most popular websites include this function (examples include Amazon, Facebook, YouTube, Wikipedia).

Training sessions should refresh the knowledge of all users and provide them with a general understanding of the ES, also explaining how the software can support their tasks (B005) and give visible results (B007) in a more efficient (B002) and effective (B006) way.

Overall, these features target directly the Learnability of the ES, which increased by 20% after the redesign.

4.1.2 Lack of Maintenance

The section on users' knowledge proposes solutions to ensure that users can learn how to utilise the ES. The guidelines are reported below in Table 13 as a reminder to the reader.

Table 14. Guidelines – Lack of Maintenance

Content Ownership	
B012	Every part of the ES should have a publicly known owner who is accountable for keeping that part updated.
B013	Regular time windows for updating every part of the ES should be established.
Difficulties in Finding Documents	
B014	The ES should not store conflicting copies of documents.
B015	The ES should not include different versions of the same document.
B016	The ES should store documents in a centralised location accessible to everyone.
B017	The ES should include shortcuts to facilitate moving across their different parts.
B018	Only a limited number of expert users should have the authorisation to create folders.

Many difficulties encountered by users during the case study were connected to finding documents and ensuring that they were correct and up to date. All maintenance measures (B012 – B018) aim to tackle this issue by making ESs more efficient (B002), effective (B006) and easy to understand (B004).

More specifically, establishing content ownership (B012) aims to prevent conflicting copies (B014), while regular updates (B013) and versioning (B015) tackle the problem of outdated documents (B014). Furthermore, a central storage unit (B016) and limited authorisations (B018) force users to store documents in the same location and prevent non-expert users from storing documents outside the appropriate location. These measures, combined with the presence of shortcuts (B017), should prevent conflicting copies (B014) and make ESs more efficient (B002) and effective (B006).

In conclusion, maintenance measures should increase both the perceived usefulness and ease of use by minimising the time users spend on non-value adding tasks. The time saved can be spent by users for activities that are more consistent with their job description (B005). In terms of measurability, a better maintenance scheme targets *Global* usability, which increased by 20% after the redesign.

4.2 Analysis of Guidelines - Functionalities

The following subparagraphs argue how the findings of the case study can be linked to those of the literature, concurrently comparing them with the parameters of software usability provided by the ISO (2011).

As a reminder to the reader, the guidelines from the literature are presented in Table 15.

Table 15. Guidelines on Functionalities – Literature Review

Deposit	
F001	The aim of knowledge stored should be balanced between exploitation and exploration.
F002	Knowledge should be stored centrally.
F003	Knowledge that is redundant or does not have a clear recipient should be removed.
Search	
F004	Relevant knowledge should be on top of the page.
F005	Knowledge should be accessible by searching for document title or document content.
F006	Search queries should include a preview of results to prevent errors.
Social Collaboration	
F007	Users should have their own profile that includes a contact and information about their role.
F008	Users should be able to learn about other users' profiles.
F009	Users should be able to contact other users.
Interface	
F010	The interface should be divided into sections.
F011	The interface should be kept as simple as possible.
F012	The interface should have minimal customisation.
F013	The interface should be standardised across different parts of the ES.
F014	The most important elements should be on the top-left part of the graphic user interface.

4.2.1 One-Screen and One-Click System

The measures that propose the creation of a One-Click and One-Screen Systems target to increase the Operability, Accessibility and User Error Protection of the software. Indeed, minimising the number of clicks (F015, F016) improves *Efficiency* by reducing the time users spend waiting for refreshing pages. The guidelines are reported below in Table 16 as a reminder to the reader.

Table 16. Guidelines – One-Click System and One-Screen System

One-Click System	
F015	The ES should offer, whenever possible, the possibility of finding content with just one click.
F016	If a One-Click System is not feasible, the ES should try to limit the number of clicks to the destination.
One-Screen System	
F017	The interface of the ES should present all content in one screen.
F018	The interface of the ES should minimise the need to scroll vertically or horizontally.

Some respondents to the SUMI mentioned the lack of an overview as the most serious problem of the ES. Therefore, a One-Screen System (F017) was proposed with the intent of providing exactly that missing overview, structured to limit vertical and horizontal scrolling (F018). This last parameter seeks to improve *User Interface Aesthetics*, while simultaneously contributing to more *Accessibility* and *Operability*, as it eliminates the need for users to scroll. Quantitatively speaking, a One-Screen System targets the *Learnability* of the ES, which has seen an increase of 20% after the redesign. Moreover, the improved aesthetics of the ES have also contributed to increasing the *Affect* (+10%), as users expressed that the new graphics are more user friendly and pleasant to use than the previous interface.

Additional features that were considered include the extensive use of modularity, as the screen was divided into sections (F010) and kept as simple as possible (F011) with vanilla (F012) and standardised implementation (F013). Said sections made use of the findings of the literature and implemented them in practice by creating a space for

social collaboration and one for research. These sections will be discussed in the following paragraphs.

4.2.2 Search

The guidelines in this section propose to improve how users search for knowledge within ESs.

This section is slightly different from the others because there is a significant overlap with the literature review. Indeed, the features requested during the round of interviews were an almost perfect match with the literature. Therefore, to avoid repetitions, this section only presents one guideline from the case study, that can be found in Table 17 as a reminder to the reader.

Table 17. Guideline – Search

Search	
F019	The ES should limit the search results to relevant files.

The case study highlighted that users want the search system to limit the scope of the results (F019) and to show a preview of those results. These two elements combined contribute to better Operability and Accessibility of the software and are consistent with the literature, which also suggests that search queries should include a preview of results to prevent errors (F006).

Besides this, the literature also suggests that the search function should show results on top of the page (F004) and allow users to access documents by searching for content and not only the title (F005). These measures were implemented during the redesign and contributed to improving the usability of the software. Their impact cannot be assessed individually, but the quantitative results show that the ES is significantly faster to use since the *Efficiency* increased by 23% after the redesign. Moreover, *Global* usability and *Learnability* both increased by 20%, and the qualitative responses to the questionnaire and interviews consistently confirmed that the new search function is more efficient and effective than the previous one. Consistently with this, *Control* and *Helpfulness* of the ES have increased by 10% after the redesign.

Another element connected to the search of information is covered by the social collaboration functionalities of ESs. In the case study, the ES presented a different interface per each geographical hub of the company before the redesign. After the project, each page had the same standardised interface and only differed slightly in the section of social collaboration since each geographical hub has different employees. Therefore, a publicly available profile to let users learn about others' profiles (F008) is a feature that in itself carries information (i.e. which users work in which geographical hub). Moreover, information cannot always be codified, and it is sometimes embrained in individuals (Newell et al., 2009). Hence, including contact information (F007) and enabling users to contact others (F009) are factors that add yet another dimension to the search function and improve the usability of the software.

4.2.3 Standardisation

This set of guidelines propose to standardise several aspects of the ES to facilitate knowledge-sharing. The guidelines are reported below in Table 18 as a reminder to the reader.

Table 18. Guidelines – Standardisation

Standardisation	
F020	The ES should present, whenever possible, the same interface on every page.
F021	The ES should present, whenever possible, the same structure for document storage on every page.
F022	The ES should integrate all parts into a comprehensive overview that is available for users to consult.

Standardising the interface (F020) increases Learnability and Accessibility of software since users must get accustomed to only one interface. It also facilitates job rotations and exchange of information between different hubs of a company since users always face the same interface – with slight differences in terms of content. This proposed functionality is equivalent to F013 from the literature, and it is also consistent with the vanilla implementation of software (F012).

In addition to the findings connected to the interface, the case study highlighted the importance of a standardised structure for depositing information. In fact, locally storing documents pushed users to create or work on different versions of the same documents, generating the multitude of problems described in paragraph 1.2. Therefore, standardising storage (F021) is vital to increase Operability and User Error Protection of ESs by preventing conflicting copies from being created, and it is consistent with the findings of the literature (F001, F002, F003).

The last functionality presented in the category of standardisation is the integration of all content into a comprehensive overview (F022). During the second round of interviews, the middle-manager especially stressed upon the importance of having a holistic and interconnected structure. Indeed, this overview aims to prevent information from being scattered and excessively compartmentalised. While dividing information into smaller bits can be beneficial (F010), a connection between all parts (F022) helps to understand how the different elements are interrelated. To explain it with a metaphor: while standardisation ensures that all pieces of the puzzle are the same, the overview serves the purpose of linking all pieces together so that users can see the full picture.

4.3 Impact on AkzoNobel

First and foremost, it is key to stress the importance of the project on which the case study was based. In fact, redesigning the ES of the department was part of the four key initiatives of AkzoNobel for the year 2020, and it was marked as a **high-priority project**.

Overall, the case study contributes to improving how the department of Decorative Coatings of AkzoNobel manages knowledge. Indeed, all guidelines were implemented and contributed to improving the usability of the ES on all grounds. The most evident example of the improvements is the drastically reduced time for users to retrieve documents, which explains why *Efficiency* of the ES has increased by 20% over a few months. Moreover, the increased usability can be sustained over time thanks to the measures on maintenance.

In addition to these, the standardised interface for all hubs may bring about several positive externalities. For instance, the high turnover of the department often meant that employees had to get used to different ways of working and storing information when they relocated to another geographical hub. With a standardised interface, onboarding a different plant will be significantly easier. Moreover, the department has been striving to streamline its processes and introduce the same tools across all regional hubs. Having a standardised interface and storage structure facilitates the exchange of information across hubs, and it is the first step to make this shift happen.

In conclusion, having redesigned the ES has brought about several positive externalities that go beyond the increased usability, and it has opened opportunities for the company to perfect its process of sharing knowledge and working collaboratively.

4.4 Limitations

The limitations of this research are characteristic of exploratory research and case studies. In summary, the specificity of the context entails finite external validity. In simpler terms, this means that the results are not generalisable to a larger population.

First of all, the findings of this thesis are based on one single case study. Therefore, the results are not generalisable to all Dutch companies or all planning departments. Similarly to an internal translation of the guidelines within AkzoNobel, an external translation to a similar department in a different company may call for changes in the guidelines. In fact, the guidelines were based on the needs of the employees of AkzoNobel in Sassenheim, and the needs of employees of a similar department in another country could differ.

Moreover, the department where the case study took place is knowledge-routinised, and the type of knowledge involved is highly operational and standardised. In practice, this limits the generalisability of the results to different departments that handle highly innovative knowledge, such as departments of research and development.

Furthermore, some guidelines may not fit into the context of other companies. For example, systematic and automatic updates of documents may be used by other companies to maintain their ES. Therefore, these companies would not need a structured system of ownership and authorisations, as described in the guidelines.

In conclusion, it may be necessary for other companies to adapt these guidelines to their context if they decide to adopt them. However, it is important to stress the importance of the results of the implementation of the guidelines, which significantly improved the usability of the ES studied. Furthermore, all guidelines were validated individually through six independent interviews that included employees with different ranks and roles.

4.5 Contributions

In addition to its contribution to AkzoNobel, this study also enlarged the existing body of literature on ESs, on software redesign and software usability. The case study was carried out with a six-sigma DMAIC technique, and the presence of the SUMI questionnaire offers a quantitative perspective on a topic that is often treated qualitatively only via interviews. Indeed, the strongest point of this thesis is the combination of qualitative and quantitative elements, which guarantee that all findings are thorough and grounded on data.

Last but not least, these guidelines can help companies create or redesign the way they work collaboratively and share information in their virtual environment. As highlighted in the introduction, the successful implementation of ESs is a problem that is shared by many companies. By following these guidelines, it should be possible for companies to facilitate this process and improve the user experience with their ES.

4.6 Further Research

An important characteristic of this case study is the time dedicated to it, namely six months. Hence, it was not possible to investigate the long-term impact of the measures applied, such as how easy it is to get accustomed to the new structure for newcomers as opposed to people who were already familiar with the ES. Further studies could investigate this element and compare the impact of measures on the two types of employees described.

Moreover, with six months available, this study could not investigate how to ensure that the value provided by ESs can be sustained over time. While some of the guidelines include elements on how to do it in theory, it was not possible to measure usability quantitatively and compare its value in a year from now. Therefore, future studies could span across longer time horizons, which is something that was not possible for this study.

Another relevant element of this study was the aspect of maintenance. The central role covered from this was apparent from the beginning of the case study, and it could be

in itself the object of a future thesis or case study. In practice, further studies could measure the importance of control plans and provide guidelines on how to draft said plans in the most effective way.

An interesting element that came across during the case study was the possibility offered from the SUMI questionnaire to filter the responses based on two parameters: the technical skills of the respondents or the importance of the software for them. Further studies could delve into how these factors influence the redesign of ESs or software usability. For example, it could be explored whether the redesign has a stronger impact on the part of the population that deems the software as "very important", or whether the different features analysed by the SUMI are somehow correlated with the technical skills of respondents.

Furthermore, it is important to mention that the same study could have been carried out with a different procedure. For example, future studies could have studied different parameters of usability through a different questionnaire instead of the SUMI.

Bibliography

Abdullah, R., Sahibudin, S., Alias, R. A., & Selamat, M. H. (2005). Collaborative Knowledge Management Systems for Learning Organisations. *Journal of Information & Knowledge Management*, *04*(04), 237–245. https://doi.org/10.1142/S0219649205001237

Ackoff, R. (1988). *From data to wisdom*.

Al-Fawaz, K., Al-Salti, Z., & Eldabi, T. (2008). *Critical success factor in ERP implementation: A review*. 9.

Al-Mashari, M., Al-Mudimigh, A., & Zairi, M. (2003). Enterprise resource planning: A taxonomy of critical factors. *European Journal of Operational Research*, *146*(2), 352–364. https://doi.org/10.1016/S0377-2217(02)00554-4

Balle, A. R., Steffen, M. O., Curado, C., & Oliveira, M. (2019). Interorganizational knowledge sharing in a science and technology park: The use of knowledge sharing mechanisms. *Journal of Knowledge Management*, *23*(10), 2016–2038. https://doi.org/10.1108/JKM-05-2018-0328

Barley, W. C., Treem, J. W., & Kuhn, T. (2018). Valuing Multiple Trajectories of Knowledge: A Critical Review and Agenda for Knowledge Management Research. *Academy of Management Annals*, *12*(1), 278–317. https://doi.org/10.5465/annals.2016.0041

Battleson, D. A., West, B. C., Kim, J., Ramesh, B., & Robinson, P. S. (2016). Achieving dynamic capabilities with cloud computing: An empirical investigation.

European Journal of Information Systems, *25*(3), 209–230. https://doi.org/10.1057/ejis.2015.12

Bingi, P., Sharma, M. K., & Godla, J. K. (1999). Critical Issues Affecting an ERP Implementation. *Information Systems Management*, *16*(3), 7–14. https://doi.org/10.1201/1078/43197.16.3.19990601/31310.2

Blackler, F. (1995). Knowledge, Knowledge Work and Organizations: An Overview and Interpretation. *Organization Studies*, *16*(6), 1021–1046. https://doi.org/10.1177/017084069501600605

Bouncken, R., & Aslam, M. M. (2019). Understanding knowledge exchange processes among diverse users of coworking-spaces. *Journal of Knowledge Management*, *23*(10), 2067–2085. https://doi.org/10.1108/JKM-05-2018-0316

Burns, J., Hyvönen, T., Järvinen, J., & Pellinen, J. (2006). The role of standard software packages in mediating management accounting knowledge. *Qualitative Research in Accounting & Management*, *3*(2), 145–160. https://doi.org/10.1108/11766090610670677

Choi, H.-J., Ahn, J.-C., Jung, S.-H., & Kim, J.-H. (2018). Communities of practice and knowledge management systems: Effects on knowledge management activities and innovation performance. *Knowledge Management Research & Practice*, *18*(1), 53–68. https://doi.org/10.1080/14778238.2019.1598578

Chuang, S.-H., & Tin-Chang Chang. (2012). Antecedents and consequences of knowledge management with IT support. *2012 International Conference on*

Information Retrieval & Knowledge Management, 69–73. https://doi.org/10.1109/InfRKM.2012.6205038

Clemons, C. (1998). *Successful Implementation of an Enterprise System: A Case Study*. 3.

Cooke, L. (2008). *An Eye-Tracking Study of Multiple Navigation Menus*. 19.

Davis, F. D. (1989). Perceived Usefulness, Perceived Ease of Use, and User Acceptance of Information Technology. *MIS Quarterly*, *13*(3), 319–340. https://doi.org/10.2307/249008

Elgohary, E. (2019). The Role of ERP Capabilities in Achieving Competitive Advantage: An Empirical Study on Dakahlia Governorate Companies, Egypt. *The Electronic Journal of Information Systems in Developing Countries*, *85*(4). https://doi.org/10.1002/isd2.12085

Esteves, J. M., & Pastor-Collado, J. A. (2002). *Understanding the ERP Project Champion Role and Its Criticality*. 11.

Fodor, J. A. (1983). *The Modularity of Mind* (Vol. 94, Issue 1, pp. 101–108). MIT Press.

Fui-Hoon Nah, F., Lee-Shang Lau, J., & Kuang, J. (2001). Critical factors for successful implementation of enterprise systems. *Business Process Management Journal*, *7*(3), 285–296. https://doi.org/10.1108/14637150110392782

Grove, E., Dainty, A., Thomson, D., & Thorpe, T. (2018). Becoming collaborative: A study of intra-organisational relational dynamics. *Journal of Financial Management of Property and Construction*, *23*(1), 6–23. https://doi.org/10.1108/JFMPC-06-2017-0018

Gunadham, T., & Thammakoranonta, N. (2019). Knowledge Management Systems Functionalities Enhancement in Practice. *Proceedings of the 5th International Conference on Frontiers of Educational Technologies - ICFET 2019*, 83–88. https://doi.org/10.1145/3338188.3338213

Hansen, M. T. (1999). The search-transfer problem: The role of weak ties in sharing knowledge across organization subunits. *Administrative Science Quarterly*, *44*(1), 82–111. https://doi.org/10.2307/2667032

Hardwig, T., Klötzer, S., & Boos, M. (2019). Software-supported collaboration in small- and medium-sized enterprises. *Measuring Business Excellence*, *24*(1), 1–23. https://doi.org/10.1108/MBE-11-2018-0098

Hearst, M. A. (2011). Search user interfaces. In *Search User Interfaces* (Vol. 9780521113793). Cambridge University Press. https://doi.org/10.1017/CBO9781139644082

Hinderks, A., Winter, D., Schrepp, M., & Thomaschewski, J. (2019). *Applicability of User Experience and Usability Questionnaires*. 19.

Hitt, L. M., Wu, D. J., & Zhou, X. (2002). Investment in Enterprise Resource Planning: Business Impact and Productivity Measures. *Journal of Management Information Systems*, *19*(1), 71–98. https://doi.org/10.1080/07421222.2002.11045716

Hunt, D. P. (2003). The concept of knowledge and how to measure it. *Journal of Intellectual Capital*, *4*(1), 100–113. https://doi.org/10.1108/14691930310455414

International Organization for Standardization. (2011). *Systems and software engineering—Systems and software Quality Requirements and Evaluation (SQuaRE)—System and software quality models*.

Joachims, T. (2002). *Optimizing Search Engines using Clickthrough Data*. 10.

Kijsanayotin, B., Pannarunothai, S., & Speedie, S. M. (2009). Factors influencing health information technology adoption in Thailand's community health centers: Applying the UTAUT model. *International Journal of Medical Informatics*, *78*(6), 404–416. https://doi.org/10.1016/j.ijmedinf.2008.12.005

Kirakowski, J. (1993). *SUMI: the Software Usability Measurement Inventory*. British Journal of Educational Technology, vol. 24, no. 3.

Kirakowski, J., & Corbett, M. (2006). SUMI: the Software Usability Measurement Inventory. *British Journal of Educational Technology*, *24*, 210–212. https://doi.org/10.1111/j.1467-8535.1993.tb00076.x

Kranz, J. J., Hanelt, A., & Kolbe, L. M. (2016). Understanding the influence of absorptive capacity and ambidexterity on the process of business model change - the case of on-premise and cloud-computing software: Understanding the dynamics of business model change. *Information Systems Journal*, *26*(5), 477–517. https://doi.org/10.1111/isj.12102

Lazar, J., Feng, J. J., & Hochheiser, H. (2017). *Research methods in human-computer interaction* (Second). Morgan Kaufmann.

Liu, M., Hansen, S., & Tu, Q. (2020). Keeping the family together: Sustainability and modularity in community source development. *Information and Organization*, *30*(1), 100274. https://doi.org/10.1016/j.infoandorg.2019.100274

March, J. G. (1991). Exploration and Exploitation in Organizational Learning. *Organization Science*, *2*(1), 71–87. https://doi.org/10.1287/orsc.2.1.71

Markus, M. L., Axline, S., Petrie, D., & Tanis, S. C. (2000). Learning from adopters' experiences with ERP: problems encountered and success achieved. *Journal of Information Technology*, *15*(4), 245–265. https://www.tandfonline.com/doi/abs/10.1080/02683960010008944

Markus, M. L., & Tanis, C. (2000). *The Enterprise System Experience—From Adoption to Success*. 36.

Naim, M. F., & Lenkla, U. (2016). Knowledge sharing as an intervention for Gen Y employees' intention to stay. *Industrial and Commercial Training*, *48*(3), 142–148. https://doi.org/10.1108/ICT-01-2015-0011

Newell, S., Robertson, M., Scarbrough, H., & Swan, J. (2009). *Managing knowledge, work and innovation* (Second edition). Palgrave Macmillan.

Nonaka, I. (1994). A Dynamic Theory of Organizational Knowledge Creation. *Organization Science*, *5*(1), 25.

Nonaka, I., & Konno, N. (1998). *The concept of 'Ba': Building a foundation for knowledge creation*.

Pil, F. K., & Cohen, S. K. (2006). Modularity: Implications for Imitation, Innovation, and Sustained Advantage. *Academy of Management Review*, *31*(4), 995–1011. https://doi.org/10.5465/amr.2006.22528166

Plotkin, H. C. (1997). *Darwin Machines and the Nature of Knowledge*. Harvard University Press, Cambridge, MA.

Remus, U. (2006). Critical Success Factors of Implementing Enterprise Portals. *Proceedings of the 39th Annual Hawaii International Conference on System Sciences (HICSS'06)*, 182a–182a. https://doi.org/10.1109/HICSS.2006.103

Rogers, E. M. (2010). *Diffusion of innovations*. Simon and Schuster.

Sabherwal, R., & Sabherwal, S. (2005). Knowledge Management Using Information Technology: Determinants of Short-Term Impact on Firm Value*. *Decision Sciences*, *36*(4), 531–567. https://doi.org/10.1111/j.1540-5414.2005.00102.x

Salahshour Rad, M., Nilashi, M., & Mohamed Dahlan, H. (2018). Information technology adoption: A review of the literature and classification. *Universal Access in the Information Society*, *17*(2), 361–390. https://doi.org/10.1007/s10209-017-0534-z

Sanchez, R., & Mahoney, J. T. (1996). Modularity, flexibility, and knowledge management in product and organization design: Modularity, Flexibility, and Knowledge Management. *Strategic Management Journal*, *17*(S2), 63–76. https://doi.org/10.1002/smj.4250171107

Seok, B. (2006). Diversity and Unity of Modularity. *Cognitive Science*, *30*(2), 347–380. https://doi.org/10.1207/s15516709cog0000_52

Silic, M., & Back, A. (2016). Factors driving unified communications and collaboration adoption and use in organizations. *Measuring Business Excellence*, *20*(1), 21–40. https://doi.org/10.1108/MBE-05-2015-0026

Somers, T. M., & Nelson, K. (2001). The impact of critical success factors across the stages of enterprise resource planning implementations. *Proceedings of the*

34th Annual Hawaii International Conference on System Sciences, 10. https://doi.org/10.1109/HICSS.2001.927129

Spender, J.-C. (1996). Making knowledge the basis of a dynamic theory of the firm: Making Knowledge. *Strategic Management Journal*, *17*(S2), 45–62. https://doi.org/10.1002/smj.4250171106

Sveiby, K. E. (1997). *The New Organizational Wealth: Managing and Measuring Knowledge-based Assets*. Berret-Koehler, San Francisco, CA.

Swan, J. (2008). *International Encyclopedia of Organization Studies* (By pages 751-753; Vol. 1–4). SAGE Publications, Inc. https://doi.org/10.4135/9781412956246

Swan, J., & Scarbrough, H. (2005). The politics of networked innovation. *Human Relations*, *58*(7), 913–943. https://doi.org/10.1177/0018726705057811

Umar, M., Khan, N., Lodhi, R. N., & Lal, C. (2018). *Analysis of Enterprise Resource Planning Implementation to Identify Critical Factors and Development of a Framework for its Success*. 8.

Urbancová, H. (2012). Conditions and principles for knowledge continuity ensuring in organizations. *Scientia Agriculturae Bohemica*, *2012*(4), 166–172. https://www.scopus.com/inward/record.uri?eid=2-s2.0-84876732218&doi=10.7160%2fsab.2012.430407&partnerID=40&md5=badc7799e650e4d81ff5df66efca06d5

Venkatesh, V., & Bala, H. (2008). Technology Acceptance Model 3 and a Research Agenda on Interventions. *Decision Sciences*, *39*(2), 273–315. https://doi.org/10.1111/j.1540-5915.2008.00192.x

Venkatesh, V., & Davis, F. D. (2000). A Theoretical Extension of the Technology Acceptance Model: Four Longitudinal Field Studies. *Management Science*, *46*(2), 186–204. https://doi.org/10.1287/mnsc.46.2.186.11926

Ward, V., House, A., & Hamer, S. (2009). Developing a Framework for Transferring Knowledge Into Action: A Thematic Analysis of the Literature. *Journal of Health Services Research & Policy*, *14*(3), 156–164. https://doi.org/10.1258/jhsrp.2009.008120

Wilden, R., Hohberger, J., Devinney, T. M., & Lavie, D. (2018). Revisiting James March (1991): Whither exploration and exploitation? *Strategic Organization*, *16*(3), 352–369. https://doi.org/10.1177/1476127018765031

Williams, J., & LaBrie, R. C. (2015). Unified communications as an enabler of workplace redesign. *Measuring Business Excellence*, *19*(1), 81–91. https://doi.org/10.1108/MBE-11-2014-0044

Appendix A - Questions for the Director of Global Supply Chain Planning and Special Projects

The questions for the Director of Global Supply Chain Planning and Special Projects have a long-term strategic perspective. They aim to understand how AkzoNobel wants to use the ES in future and how to incorporate AkzoNobel's vision in the ES.

Questions:

1. What functions do you want SharePoint to cover?

2. Is there any discrepancy in the usage of the SharePoint in practice and the usage of the SharePoint in theory?
    a. You expected some functions to be covered and they were not covered
    b. You did not expect some tasks to be covered yet they were covered

3. The department has adopted the Continuous Improvement (CI) culture and embedded it into its day-to-day activities. Are you willing to integrate the CI culture in SharePoint as well?
    a. For example, the DMAIC[1] structure in the Projects page: should it be added or not? If yes, should it be the only part there?
    b. What about the house of planning, can / should we remove it from the Projects page?

4. Is there anything in the structure of SharePoint that should be changed to align with your long-term vision? Do you have any ideas on what to improve?

[1] A six-sigma technique for project management. DMAIC stands for "Define, Measure, Analyse, Improve, Control".

Appendix B - Questions for regional managers

The questions for regional managers have a mix of long-term strategic view and short-term operative perspective. Their objective is to understand how managers use the software and how to adapt it to their needs.

Questions:

1. How often do you use SharePoint?
    a. If not that often, why?

2. In your daily tasks, what are the issues that you face when trying to use SharePoint?
    a. Is there something that has annoyed you in the recent past or you were unable to do?
    b. Is there room for improvement in some areas of SharePoint? Do you have any ideas, or would you like to propose something?
    c. How do you get to a document that you want to find? Is it bookmarked?

3. On main the page of your regional hub, what features would you like to have?
4. From the categories featured on the left in SharePoint interface, which have you used or opened? Which do you open regularly?

5. What do you think about the Projects page with the house of planning? Would you want it to be changed?
    a. Would you want it to be changed or not?
    b. Is it informative?
    c. Do you find the current house of planning to be a suitable format, if you want to be updated on the projects?

6. What folders would you like to have and how would you like your hub to be structured?

7. Attached is a link to the hub that we will use as a template to structure the other hubs. What are your thoughts on this structure?

8. What do you think is the most effective way of explaining the features of the SharePoint?
    a. Video
    b. Manual
    c. Meeting
    d. Any combination of the three

9. From your team, who should we interview next?

10. If at any time there is anything that you think could help, please feel free to drop me an email, come by my office or set a meeting.

Appendix C - Questions for planners

The questions for planners have a short-term operative perspective. They aim to understand potential barriers and functionalities of the software before the redesign.

Questions:

1. How often do you use SharePoint?
2. What do you use SharePoint for?
3. What type of problems do you face while using SharePoint?
4. What documents do you use on a daily basis? Where are these documents stored?
5. What documents do you use on a weekly basis? Where are these documents stored?
6. What documents do you use on a monthly basis? Where are these documents stored?
7. Are there any documents that you use that are specific to your geographical hub?
8. If you were to propose three to five categories for documents, which would these be?
9. What documents did you read when you were onboarding?
10. What training manuals and best practices did you need access to? Were you able to find them?
11. What manuals do you think someone who is new to the company really needs to read?
12. (Only for people with some years of experience) What manuals do you think someone who has been in the company for a while needs?

Appendix D – SUMI Questionnaire

The following screenshots are taken from the official website of the SUMI questionnaire, which is accessible via this link: http://sumi.uxp.ie/

Software Usability Measurement Inventory

SUMI

NB The information you provide is kept completely confidential and no information is stored on computer media that could identify you as a person.

This questionnaire has 50 statements. Please answer them all. After each statement there are three boxes.

- Check the first box if you generally AGREE with the statement.
- Check the middle box if you are UNDECIDED, or if the statement has no relevance to your software or to your situation.
- Check the right box if you generally DISAGREE with the statement.

In checking the left or right box you are not necessarily indicating strong agreement or disagreement but just your general feeling most of the time.

There are also some general questions at the end.

Password:

What, in general, do you use this software for?

Statements 1 - 10 of 50.	Agree	Undecided	Disagree
This software responds too slowly to inputs.	○	○	○
I would recommend this software to my colleagues.	○	○	○
The instructions and prompts are helpful.	○	○	○
This software has at some time stopped unexpectedly.	○	○	○
Learning to operate this software initially is full of problems.	○	○	○
I sometimes don't know what to do next with this software.	○	○	○
I enjoy the time I spend using this software.	○	○	○
I find that the help information given by this software is not very useful.	○	○	○
If this software stops it is not easy to restart it.	○	○	○
It takes too long to learn the software functions.	○	○	○

Statements 11 - 20 of 50.	Agree	Undecided	Disagree
I sometimes wonder if I am using the right function.	○	○	○
Working with this software is satisfying.	○	○	○
The way that system information is presented is clear and understandable.	○	○	○
I feel safer if I use only a few familiar functions.	○	○	○
The software documentation is very informative.	○	○	○
This software seems to disrupt the way I normally like to arrange my work.	○	○	○
Working with this software is mentally stimulating.	○	○	○
There is never enough information on the screen when it's needed.	○	○	○
I feel in command of this software when I am using it.	○	○	○
I prefer to stick to the functions that I know best.	○	○	○

Statements 21 - 30 of 50.	Agree	Undecided	Disagree
I think this software is inconsistent.	○	○	○
I would not like to use this software every day.	○	○	○
I can understand and act on the information provided by this software.	○	○	○
This software is awkward when I want to do something which is not standard.	○	○	○
There is too much to read before you can use the software.	○	○	○
Tasks can be performed in a straight forward manner using this software.	○	○	○
Using this software is frustrating.	○	○	○
The software has helped me overcome any problems I have had in using it.	○	○	○
The speed of this software is fast enough.	○	○	○
I keep having to go back to look at the guides.	○	○	○

Statements 31 - 40 of 50.	Agree	Undecided	Disagree
It is obvious that user needs have been fully taken into consideration.	○	○	○
There have been times in using this software when I have felt quite tense.	○	○	○
The organisation of the menus seems quite logical.	○	○	○
The software allows the user to be economic of keystrokes.	○	○	○
Learning how to use new functions is difficult.	○	○	○
There are too many steps required to get something to work.	○	○	○
I think this software has sometimes given me a headache.	○	○	○
Error messages are not adequate.	○	○	○
It is easy to make the software do exactly what you want.	○	○	○
I will never learn to use all that is offered in this software.	○	○	○

Statements 41 - 50 of 50.	Agree	Undecided	Disagree
The software hasn't always done what I was expecting.	○	○	○
The software presents itself in a very attractive way.	○	○	○
Either the amount or quality of the help information varies across the system.	○	○	○
It is relatively easy to move from one part of a task to another.	○	○	○
It is easy to forget how to do things with this software.	○	○	○
This software occasionally behaves in a way which can't be understood.	○	○	○
This software is really very awkward.	○	○	○
It is easy to see at a glance what the options are at each stage.	○	○	○
Getting data files in and out of the system is not easy.	○	○	○
I have to look for assistance most times when I use this software.	○	○	○

How important for you is the kind of software you have just been rating?

- ○ Extremely important
- ○ Important
- ○ Not very important
- ○ Not important at all

How would you rate your software skills and knowledge?

- ○ Very experienced and technical
- ○ I'm experienced but not technical
- ○ I can cope with most software
- ○ I find most software difficult to use

What do you think is the best aspect of this software, and why?

What do you think needs most improvement, and why?

When you've answered all the questions:
please click the 'Send' button.

Send

4.2 SUMI EN 4.0

Appendix E – Questions for the second round of interviews

The second round of interviews aimed to validate the findings of the case study and understand barriers and functionalities of ESs thoroughly. The interviewees included two middle-level managers and four planners.

Questions:

The barriers were explained one by one and discussed with the interviewee.

1. The main barriers identified include users' knowledge, difficulties in finding information. Do you agree with these categories?
2. Is there any other barrier that you think should be mentioned?

The functionalities were explained one by one and discussed with the interviewee.

3. The main functionalities included in the redesign concern deposit, social collaboration, search and interface. Do you agree with these categories?
4. Is there any other functionality that you think should be implemented?

5. If at any time there is anything that you think could help, please feel free to drop me an email or set a Skype meeting.

Appendix F – Guidelines on barriers and further findings

Table 19. Overview of Guidelines on Barriers

Perceived Ease of Use	
B001	The ES should not force users to be familiar with all their functionalities in order to achieve results.
B002	The ES should provide results more efficiently compared to alternatives.
B003	The ES should be compatible with existing websites or applications that serve their purpose.
B004	The ES should not be difficult to understand or use.
Perceived Usefulness	
B005	The ES should be consistent with the tasks that users have to perform in the company.
B006	The ES should provide results more effectively compared to alternatives.
B007	The ES should provide results that are visible to users.
Users' Knowledge	
B008	The ES should include a FAQ section and keep it updated.
B009	The ES should include manuals and tutorials that explain how to use the software.
B010	Divide users based on their expertise and make this structure public so that everyone knows who to approach with questions.
B011	Regular training on the functionalities of the ES and the rationale behind its structure should be organised.
Content Ownership	
B012	Every part of the ES should have a publicly known owner who is accountable for keeping that part updated.
B013	Regular time windows for updating every part of the ES should be established.

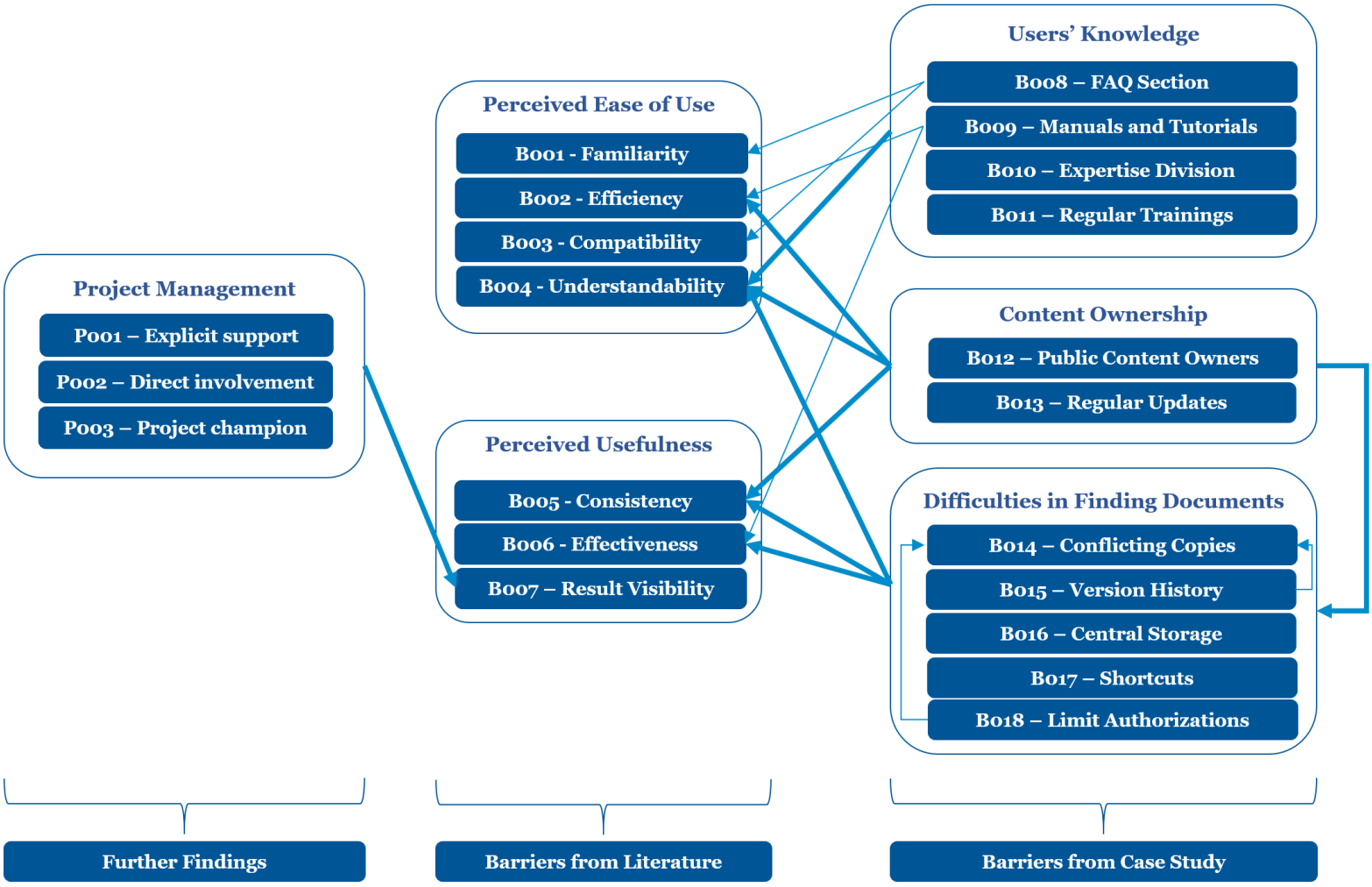
Difficulties in Finding Documents	
B014	The ES should not store conflicting copies of documents.
B015	The ES should not include different versions of the same document.
B016	The ES should store documents in a centralised location accessible to everyone.
B017	The ES should include shortcuts to facilitate moving across their different parts.
B018	Only a limited number of expert users should have the authorisation to create folders.

Table 20. Overview of Further Findings

Project Management	
P001	Gather explicit and public top management support.
P002	Involve top management directly in the redesign.
P003	Choose a project champion from the senior management of the company.

Figure 7 below schematises how the guidelines on barriers are related to each other. Less thick lines connect single guidelines, while thicker lines connect a group of guidelines to a single guideline or another group of guidelines.

Figure 7. Interactions Between Guidelines on Barriers



Appendix G – Guidelines on functionalities

Table 21. Overview of Guidelines on Functionalities

Deposit	
F001	The aim of knowledge stored should be balanced between exploitation and exploration.
F002	Knowledge should be stored centrally.
F003	Knowledge that is redundant or does not have a clear recipient should be removed.
Search	
F004	Relevant knowledge should be on top of the page.
F005	Knowledge should be accessible by searching for document title or document content.
F006	Search queries should include a preview of results to prevent errors.
Social Collaboration	
F007	Users should have their own profile that includes a contact and information about their role.
F008	Users should be able to learn about other users' profiles.
F009	Users should be able to contact other users.
Interface	
F010	The interface should be divided into sections.
F011	The interface should be kept as simple as possible.
F012	The interface should have minimal customisation.
F013	The interface should be standardised across different parts of the ES.
F014	The most important elements should be on the top-left part of the graphic user interface.
One-Click System	
F015	The ES should offer, whenever possible, the possibility of finding content with just one click.

F016	If a One-Click System is not feasible, the ES should try to limit the number of clicks to the destination.
One-Screen System	
F017	The interface of the ES should present all content in one screen.
F018	The interface of the ES should minimise the need to scroll vertically or horizontally.
Search	
F019	The ES should limit the search results to relevant files.
Standardisation	
F020	The ES should present, whenever possible, the same interface on every page.
F021	The ES should present, whenever possible, the same structure for document storage on every page.
F022	The ES should integrate all parts into a comprehensive overview that is available for users to consult.

Figure 8 below schematises how the guidelines on functionalities are related to each other. Less thick lines connect single guidelines, while thicker lines connect a group of guidelines to a single guideline or another group of guidelines.

Figure 8. Interactions between Guidelines on Functionalities