

Sonja Rainio

“THE PRODUCT MANUAL IS THE BIBLE”
The usability of a heavy machinery product manual in
information seeking

ABSTRACT

Sonja Rainio: "The product manual is the bible": The usability of a heavy machinery product manual in information seeking

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This study examines the usability of a heavy machinery product manual and the information seeking processes the document's users engage in when they utilise the document. The purposes of this study are to describe the information seeking processes of the product manual's users, to evaluate the usability of the product manual based on the users' reported experiences, and to determine alterations which could improve the usability of the document. This study was conducted for a heavy industry company which operates globally in the industrial engineering and manufacturing industry.

The theoretical framework of the thesis combines two fields of research, information behaviour and usability research. The aspects of these fields that are relevant to this study include information needs and information seeking as well as the facets of usability in textual systems. This study examines the relationship between these two fields in the context of hardware user documentation.

The material was collected with focus group discussions and the analysis was conducted with a qualitative content analysis. The participants in the discussions represent real users of the product manual, tendering engineers and design engineers. These users routinely utilise the product manual in a professional information seeking context.

The results of this study suggest that the usability of a documented information source is closely determined by efficiency in terms of time-consumption. If users perceive the document as inefficient to use, they typically opt for optional strategies of information seeking. The key usability issue as regards the product manual is efficiency, which comprises several aspects, such as the findability of information, information design, and the comprehensibility of information. These areas of efficiency should be considered in the documentation process because they can improve the usability of the documentation in information seeking.

Keywords: information behaviour, information seeking, usability, usability testing, technical documentation

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Tässä tutkielmassa tarkastellaan raskaankaluston tuotemanuaalin käytettävyyttä osana tiedonhankintaprosessia. Tutkimuksen tavoitteena on kuvata tuotemanuaalin käyttäjien tiedonhankintaprosesseja, arvioida tuotemanuaalin käytettävyyttä käyttäjien raporttien kokemusten perusteella sekä esittää muutosehdotuksia, joiden avulla dokumentin käytettävyyttä voitaisiin parantaa. Tutkimus tehtiin raskaan teollisuuden yritykselle, joka toimii kansainvälisesti teollisuuden suunnittelu- ja valmistussektorilla.

Tutkielman teoreettinen viitekehys yhdistää kaksi tutkimusalaa, tietokäyttäjien ja käytettävyyden tutkimuksen. Näiden alojen relevantteja aihealueita tässä tutkielmassa ovat tiedontarpeet ja tiedonhankinnan prosessit sekä tekstijärjestelmien käytettävyyden osa-alueet. Tutkielmassa tarkastellaan tietokäyttäjien ja käytettävyyden välistä suhdetta kone- ja laitetekniikan dokumentaation kontekstissa.

Aineisto kerättiin fokusryhmähaastatteluilla ja analyysimenetelmänä käytettiin laadullista sisällönanalyysia. Haastattelujen osallistajat edustavat tuotemanuaalin todellisia käyttäjiä: tarjous- ja suunnitteluinsinöörejä. Nämä käyttäjät käyttävät tuotemanuaalia säännöllisesti osana työtehtäviinsä liittyvää tiedonhankintaprosessia.

Tutkielman tulokset osoittavat, että keskeisin dokumentoidun tietolähteen käytettävyyteen vaikuttava tekijä on tehokkuus. Dokumentaation tehokkuus näkyy erityisesti tiedonhakuun käytetyssä ajassa. Dokumentaation tehokkuus vaikuttaa myös tietolähteen valintaan, sillä käyttäjät todennäköisesti valitsevat tiedonhakutilanteessa tehokkaimmaksi mieltämänsä tietolähteen. Tehokkuuteen ja ajankäyttöön vaikuttavia tekijöitä dokumentaatiossa ovat esimerkiksi tiedon löydettävyys, muotoilu ja ymmärrettävyys. Nämä tehokkuuden osa-alueet on hyvä ottaa huomioon dokumentointiprosessissa, sillä niiden avulla voidaan parantaa dokumentaation käytettävyyttä tiedonhaussa.

Avainsanat: tietokäyttäjien, tiedonetsintä, käytettävyys, käytettävyydestatus, tekninen dokumentaatio

Tämän julkaisun alkuperäisyys on tarkastettu Turnitin Originality Check -ohjelmalla.

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1 INTRODUCTION

Producing user instructions is an integral part of product development and design (Euroopan integraatio 1993, 6). The term *user instructions* refers to different information types which convey to the user information on a product or its use (*Ibid*, 5). The contents of user instructions depend on the perceived user, or reader, of the documentation, because different types of users have different requirements for user documentation. For example, the European Integration states that professional users typically possess intricate information on a product or its functions. Therefore, their requirements for user documentation are different from the those of consumer product users (*Ibid*, 6).

Different professional user groups have different types of information behaviours that they engage in when they utilise user instructions. Information behaviour refers to a process in which an information user encounters an information need and proceeds to seek information to fulfil that need (Wilson 2006, 659). Users' information needs vary according to their level of knowledge or expertise on the product in question. Private individual users are typically concerned with the actual use of a product (Euroopan integraatio 1993, 6). For this reason, the emphasis of the user documentation of consumer products is on the actual use of a product and not, for example, its maintenance (*Ibid*). Conversely, professional users of, for instance, heavy machinery, are typically concerned with the limitations and technical qualities of product components instead of the actual use of a product (*Ibid*, 7).

Regardless of the intended user group, a central aspect in the development of any product is *usability*. Usability refers to a set of quality components which assess how easy a user interface is to use (Nielsen 2012). Traditionally, usability is associated with the design and development of software technology. Despite this emphasis on human-computer interaction, almost any human activity can be considered from the perspective of usability (Suojanen et al. 2015, 14).

Interaction with user instructions falls rather naturally within the scope of usability research; such documents are an integral part of the devices, systems, and products that are the traditional target of usability testing (Suojanen et al. 2012, 10).

Because one potent function of user documentation is to communicate information on a product, this research combines the concepts of usability testing and information behaviour. The usability of user documentation in information seeking may be concerned with:

- how well documentation responds to its users' information needs
- how effectively the users are able to utilise the document in their information seeking process.

The usability of user documentation in information seeking is a viable topic of research because the primary function of a user document is to provide information. Wilson (2006, 662) also states that data derived from information needs studies is useful especially when the goal is to redesign information systems to be more efficient or more effective. Therefore, research into the usability of user documentation in information seeking can produce results which aid a company in making their documentation more usable.

The topic of this thesis is the usability of a heavy industry product manual as an information seeking tool. I conduct this research for a heavy industry company which operates globally in the industrial products and machinery section. The company is a publicly traded company in the industrial engineering and manufacturing industry. The company offers a variety of product solutions and product maintenance services for certain heavy industry processes. The idea for this thesis developed when I interned at the company and worked on the structured documentation version of the product manual. The idea to combine the frameworks of usability and information behaviour arose from my preliminary observations of the product manual during the internship.

The product manual in question is an electronic document the primary purpose of which is to provide information on the configuration of a specific product line. This product line consists of similar heavy machinery products which are related in terms of their functionality and marketed under one brand name. In terms of its contents, the product manual centres on the theoretical operations of and referential information on the product with less emphasis on task-oriented

instructions. The users of the manual include tendering and design engineers who utilise the information in the product manual in their daily work tasks.

The manual currently exists in PDF format and has until recently only been available in linear documentation format. The first structured data version of the document was published for use in January 2024. In this research, I examine the linear version of the document because the structured version was not yet available when I conducted the study.

In this thesis, I seek to describe the users' information seeking strategies and the role and usability of the product manual in the information seeking process. By discussing these issues, my objective is to address the following questions:

1. What kind of information needs and information seeking processes do the users have?
2. How do the users utilise the product manual in information seeking?
3. How do the users perceive the product manual in terms of its usability?

There exists relatively little previous research on the usability of heavy machinery user instructions, whereas a wealth of research has been produced in the software domain. For example, minimalist heuristics – strategies designed to help improve the usability of designs – are a tool frequently employed to evaluate the usability of software applications and software user instructions. However, the relationship and context between minimalism and heavy machinery has rarely been discussed (Pöyhönen 2023, 20).

Although research on the usability of heavy machinery user instructions is scarce, there are results which suggest that the tools for evaluating the usability of software user documentation are also applicable for evaluating heavy industry user documentation. Studies as to the usability of heavy machinery user instructions typically employ heuristic evaluation as the method of usability testing. Virtaluoto et al. (2021) have proposed a revised set of minimalist heuristics intended for the evaluation of both software and hardware user instructions. The first study as to the applicability of these heuristics in the heavy machinery context was a workshop conducted by Suomivuori et al. (2020). The results suggested that the heuristics are tentatively suitable for testing the usability of heavy machinery user instructions (*Ibid*, 237). Pöyhönen (2023)

further studied the applicability of these revised heuristics in the domain of heavy machinery user instructions. Her results suggest that the majority of the heuristics are indeed suitable for evaluating the usability of heavy industry products (*Ibid*, 51).

There exists a fair amount of research on the relationship between information behaviour and documentation. However, the studies are predominantly concerned with how software engineers use documentation in information seeking (see O'Brien 2014; Seaman 2002; Poltrock et al. 2003). In contrast, studies on hardware user documentation in information seeking are virtually non-existent. With this research, I intend to contribute to the limited supply of research on the usability of hardware user instructions. However, the approach I adopt in this thesis is different from the minimalism-centred heuristic evaluation of earlier studies. Instead, I address the issue of usability through the lens of information behaviour by conducting a user interview. User interviews can reveal information on the users' experiences and needs (Rosala and Pernice 2023) and consequently produce data which is beneficial for improving a product.

This thesis comprises six subsequent sections. In sections 2 and 3, I introduce the theoretical framework of this study, which consists of information behaviour and usability. In section 4, I describe the research material and the methods I employed to collect and analyse the material. Section 5 contains the analysis of the research material. In section 6, I summarise and discuss the results of the analysis. Finally, in section 7, I provide a brief summary of the study and present suggestions for successive research.

2 INFORMATION BEHAVIOUR

This section describes information behaviour and the processes with which it is concerned. I first discuss the definition of information behaviour along with definitions of related concepts. I then describe in further detail two of these concepts which are of relevance to this thesis: information needs and information seeking.

2.1 *The definition of information behaviour*

The term *information behaviour* (also *information practices*) is an umbrella term which denotes the methods people generally utilise to process information (Savolainen 2007, 109). The term emerged in use in mid-1960s and began to establish its position in the conceptualisation of information needs, seeking, and use in the 1970s (*Ibid*, 112–113). Although rooted in library and information science, information behaviour is a concept of research relevant to a number of disciplines (Wilson 1997, 551). Different disciplines have their own motivations for understanding how people seek, utilise, or gain access to information (*Ibid*).

In defining information behaviour, a term which demands definition is *information*. The term has countless definitions, and there exists no generally agreed-upon definition or theoretical conception of *information* (Bates 2017, 2048). In the context of user studies research, *information* can refer to several items, such as physical entities or phenomena, communication channels, or factual, empirically determined data (Wilson 2006, 659).

Above, Wilson (2006, 659) connects the definition of information to *data*, another term with no all-encompassing definition. Information should also be distinguished from another term often used synonymously with it: *knowledge*. The relationship between the conceived definitions of *data*, *information*, and *knowledge* has been investigated by Zins (2007, 483, 484, 486). According to his findings, the differences between these concepts relate to both their inherent

qualities and their relation to the information user. *Data* is frequently understood as raw, unprocessed, or isolated facts, whereas information is aggregated data with context and relationships. Knowledge, in turn, is information which creates meaningful connections with other sets of information and exists in one's personal, cognitive framework.

Due to the different possible definitions and their overlap, each researcher should explicitly define what *information* means in the context of her research to avoid confusion or ambiguity (Wilson 2006, 659). In the framework of this thesis, *information* denotes any piece of technical information that users require to perform or progress their work tasks. The information pertains to the product line in question and the users can find it in the product manual, in another information source, or in both. Some of the contents of the product manual are highly numeric and isolated, in which cases the information leans more towards Zins' definition of *data*. Regardless, I refer to the numeric data in the product manual also as information because making a distinction between the two is not relevant in this research. As regards *knowledge*, I use the term in the analysis to refer to the type of information the users typically seek when they consult human sources.

In the field of library and information science, virtually all developments have been concerned with facilitating users' access to documents or information (Wilson 2008, 457). However, studies and theories which focus on the users' behaviour rather than the use of information systems only began to appear in the 1980s (*Ibid*, 457, 459). Wilson (2006, 659) has suggested a seminal model which illustrates the relationships between the concepts involved in user-oriented information behaviour. The information processes in the model are defined in terms of user behaviour – an individual information user engages in information seeking behaviour to respond to a perceived need (Wilson 1994). The figure below presents the model of information behaviour.

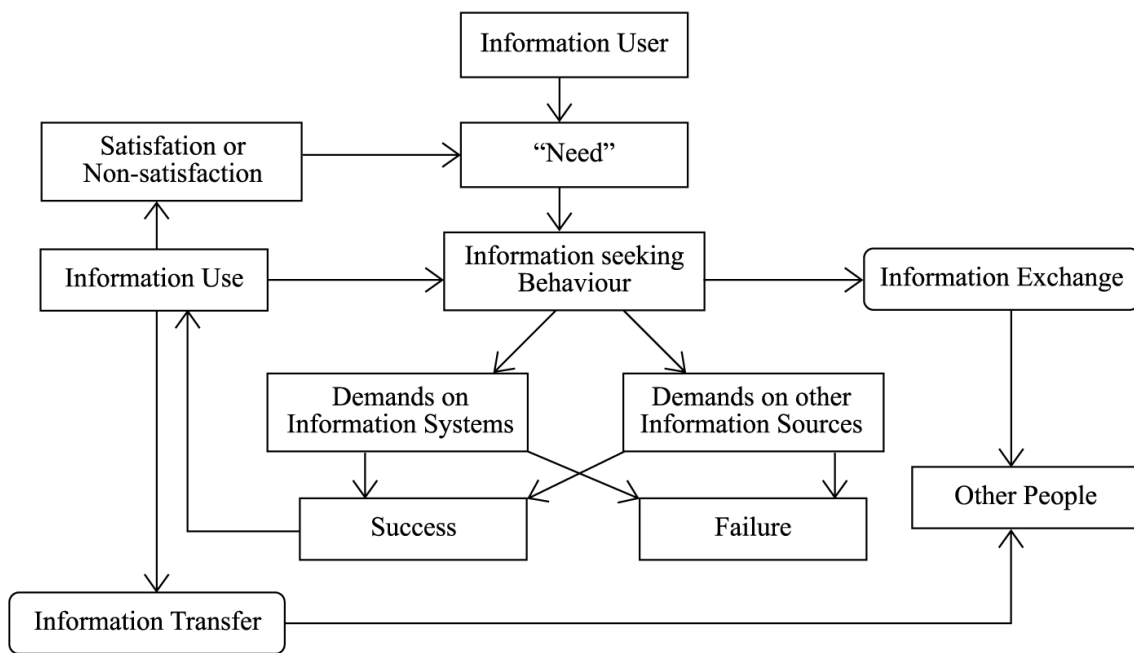


FIGURE 1. The model of information behaviour (Wilson 2006, 659)

The premise in Wilson’s information behaviour consists of an information user, an information need, and the information seeking behaviours the user employs to respond to the need. According to the Online Dictionary for Library and Information Science, *users* are people who engage with the resources and services of libraries (Reitz, “Patron”). This definition in relation to Wilson’s model suggests that information users are those who engage with information systems and information sources in order to fulfil their information needs. In this research, *information user* denotes the same referent as *product manual user*. I discuss users in the context of usability further in section 3.2.1.

Information needs represent “the starting point and motivation that brings a user to engage in the process of information seeking” (Naumer and Fisher 2009, 2457). Information needs may arise both in everyday situations and in the context of work, for instance. If the primary motivation behind information behaviour is performing work tasks, the context is the need, seeking, and use of professional information (Savolainen 2010, 80). The motives behind information needs can vary from mere personal interest to demands which determine whether an information user manages to complete a certain task. In this study, the latter aspect is the more relevant one.

As evident in Wilson's model (see figure 1), information seeking behaviour is a term which comprises various related concepts and functions which the information user engages in to fulfil her information need. According to a simple definition, "information seeking involves the search, retrieval, recognition, and application of meaningful content" (Kingrey 2002). Information seeking can involve information systems and information sources for which the user has demands, or inquiries.

Another possible route in information seeking behaviour is information exchange. Information exchange occurs between the information user and another person, that is, a human source. Human sources provide information in fundamentally different format than documented information sources. Documented sources, such as physical or electronic books, can contain information in various formats, including text, illustrations, and audio (Savolainen 2010, 75–76). As regards human sources, on the other hand, users can only acquire information via communication (*Ibid*). The users in this study utilise human sources especially in situations where their information needs pertain to topics outside their personal expertise.

The information seeking process can result in either failure or success. Failure refers to a situation where the user is unable to find the information she needs. In Wilson's model, failure seemingly depicts a stalemate for the information user. However, a natural consecutive step when the user reaches failure would be to recommence the information seeking process. If information seeking is successful, the user finds information that she deems relevant to her information need. Although not shown in the model, information exchange can also result in information use when a user evaluates the suitability of the received information to her information needs.

Successful information seeking is followed by information use, which can entail the user utilising the information herself or transferring it to another party. Information transfer may occur, for instance, when the information user perceives the information she has acquired to be relevant to the information need of another user. Information transfer can be a goal in itself, as in the context of information acquiring and sharing. According to this framework, information users seek information to respond to both their own needs and motivations as well as those of other people (Rioux 2005, 169). As the analysis reveals, the users in this study

seek information not only to satisfy their own information needs but also the needs of other parties, such as those of customers.

Information use can be satisfactory or non-satisfactory. The use is satisfactory when the information the user has acquired fulfils her information need and non-satisfactory when it does not fulfil the information need (Wilson 2006, 660). According to Wilson (*Ibid*), the correctness of information is irrelevant to information use, as a user can also attempt to use information which might not actually fulfil the information need. The correctness of information is only relevant in the consecutive step on satisfaction, as incorrect information results in non-satisfactory information use. If the information use does not satisfy the user's information need, the user may recommence with the information seeking process.

The two concepts in Wilson's (2006, 659) model that are most relevant to the present thesis are information needs and information seeking behaviour, whereas the aspect of information use falls outside the scope of the analysis. In the two subsequent sections, I further elucidate the concepts of information needs and information seeking behaviour.

2.2 *Information needs*

According to Wilson (2006, 662), research on information needs is concerned with questions such as:

- Why does a user decide to seek information?
- What purpose does the user believe the information will serve?
- To what use does the user put the information when she receives it?

Similarly to the term *information*, the definition of *information needs* depends on the context and purpose of each individual study. Because of its dependence on context, the term has acquired several different definitions. In information transfer, for instance, information needs are defined in terms of information objects, such as books or documents (Naumer and Fisher 2009, 2455). In such cases, information needs can be represented as interactions between information users and information systems (*Ibid*). Conversely, a social constructionist view places information needs into a larger social realm where the needs of a social

group should harbour consideration in addition to the needs of the individual (*Ibid*, 2456).

The approach most relevant to the present study is the constructionist, or cognitive, paradigm. From a constructionist viewpoint, such as that of Wilson, information needs are a part of a larger situation, not individual or isolated instances (Naumer and Fisher 2009, 2456). A constructionist definition of information needs suggests that the needs arise from the level of knowledge a person has on a given topic and his proficiency with the processes involved with topic (*Ibid*, 2455). Therefore, the motivation for seeking information derives from lack of knowledge (*Ibid*, 2456). This notion is in accordance with Wilson's (1994,) remark that when a person lacks knowledge on a certain issue, he encounters an information need and begins the information seeking process. In a professional environment, such as the workplace, the users' level of knowledge is closely connected to their experience level, which affects information needs. Gaps in knowledge may occur more frequently among novice employees, whereas experienced employees are more familiar with the topics and processes relevant to their work.

In this study, information needs concern situations where a user requires additional information in order to proceed with his work task. A gap in knowledge disrupts or hinders the user's workflow, which results in the user beginning the information seeking process. The information need then prompts the user to seek information in the product manual or from other sources, such as colleagues.

2.3 Information seeking behaviour

In Wilson's (Wilson 2006, 659) model, information seeking begins with selecting the appropriate information seeking method. The user has three possible routes through which she can attempt to fulfil the information need. The user can seek information in an information system, such as a library or information centre (Wilson 2006, 660). For these systems, providing information is the primary or sole function. Another option is to seek information in other information sources for which information functions are a secondary function (*Ibid*). Such sources can be, for example, agencies that primarily sell products or services but can also provide information on certain aspects of them (*Ibid*). The third possible route

through which to seek information is information exchange. In information exchange, the user seeks information, advice, or opinions from other people instead of from information systems (*Ibid*). In this study, the primary information system is the product manual, whereas the other route of information seeking the users employ is information exchange.

There are several possible factors that affect the information seeking strategy an information user selects to employ. Firstly, the method a user selects depends on situational factors. Formal information seeking situations, such as those related to school projects, may require the user to employ organisational information systems (Kingrey 2002). In addition to the information seeking situation, the information need of the user affects the information seeking process. Simple, fact-oriented information needs require simple information seeking processes (*Ibid*). For example, in an everyday situation, a user can employ Google Search to fulfil a simple information need. In such situations, selecting the information seeking path is uncomplicated and transparent – the user knows where she can likely find information. Complex problem-solving, conversely, requires considerable thought and effort (*Ibid*), and the information seeking process is likely complex, as well.

Thirdly, users may be ignorant of formal information systems (Wilson 2006, 662). On the other hand, users may find information seeking more efficient or effective through another route (*Ibid*). Efficiency, in this context, can refer to the response delivery speed (*Ibid*), that is, how quickly the user receives an answer to their inquiry. Effectiveness can refer to quality or currency of the information the user receives (*Ibid*). An effective path of information seeking is thus one that the user perceives as more likely to produce correct or relevant information.

A distinction should also be made between *information seeking* and *information searching*. Whereas information seeking is a process concerned with different procedures and phases, information searching is narrower in meaning. Information searching refers to how a user interacts with an information system in situations where they know what they need to find. Information searching involves the use of different strategies the user can employ to find the information they require. Saastamoinen (2017, 28) mentions that potential strategies of searching for information in electronic sources include queries, browsing, and following hyperlinks, for instance. In this research, the most prevalent information

searching strategies the user employ with the product manual were queries and browsing.

Fulton and McGuinness (2016, 122) use the strategy of querying synonymously with information searching. According to the authors, querying refers to “well-defined, targeted information seeking for a clearly articulated information need, that is, when you have a fairly clear idea of the kind of information you need” (*Ibid*). Querying is, in essence, targeted searching, where the information user has a fairly concrete idea of the type of information she needs to find. An example of querying is using the Find function (Ctrl-F) on a website or in a PDF document and entering search words or terms to locate relevant instances in the text.

Browsing, in turn, is defined by Fulton and McGuinness (2016, 123) as *non-targeted searching*. When a user browses for information, his information need is likely poorly defined or generic, or the topic to which the information need pertains is unfamiliar to the user (*Ibid*). Browsing is characterised by skimming through information in the hope of finding information relevant to the information need at hand. As the analysis shows, the users in this study engage in browsing for instance in situations where they know the product manual contains information on a certain topic, but they are unsure where in the document it is located.

To summarise this brief introduction to information behaviour, the process of information behaviour, as proposed by Wilson (2006), consists of an information user who encounters an information need. The information need then acts as the motivation which spurs the user to seek information. The user can select to seek information from different sources, depending on, for instance, which information source the user deems most suitable for her needs. Information seeking also involves information searching, which refers to the concrete actions a user takes to fulfil her information need. Information searching can include, for example, using search functions or browsing for information. Information seeking results in information use, where the user attempts to fulfil her information need with the information she has acquired. If the information is suitable for her needs, the information seeking process has resulted in satisfaction for the user. If the information is unsuitable to fulfil the information need, the user may recommence information seeking and seek new or additional information.

3 USABILITY

In this section, I present the core aspects related to usability and usability testing. I begin with a brief introduction to the history of usability and usability testing. I then proceed to discuss the terms and concepts relevant to usability or usability testing. In discussing usability testing, I summarise some of the prominent methods of conducting usability tests. Finally, I review some of the benefits of and criticism towards usability testing.

3.1 A brief history of usability and usability testing

The notion of making designs more usable and useful has been a core concern in the field of technical and professional communication since its early stages (Johnson et al. 2007, 320). Technological development along with the military industry of the first half of the twentieth century resulted in the need of efficient and accurate technologies (*Ibid*, 321). Efficiency and accuracy then formed the initial concerns for effective technical communication. The authors note that the former referred to “making technology more efficient in terms of time and cost”. The latter, which emerged due to the development of more complex technologies, referred to using technology accurately to meet the goals of human actions (Johnson et al. 2007, 321).

Although its origins date back to the early twentieth century, the term *usability* only emerged around the 1980s when personal computers became more affordable. This revolution of declining hardware prices and proliferation of personal computers made the products accessible to a wider range of users who utilised them for a variety of different tasks (Nielsen 1993, 8). The user base for computers rapidly increased and diversified as the typical user shifted from programmers and engineers to secretaries and professionals (Carroll 1998, 2).

This new user base for computers created new usability requirements for computer products. Technology companies could no longer expect users to have

engineer-level training, to spare the time carefully reading lengthy manuals, or to tolerate troublesome user interfaces (Carroll and Rosson 1984, 1). To determine the needs of these reshaped user groups, companies began to conduct user studies. The objectives of these tests were to determine what potential users need to do and how they want to do it (*Ibid*, 9). These user studies involved the users' perspective in the design process, which is the focus of user-centred design (Kuutti 2003, 140). User-centred design methods date from the 1960s when usability began to be acknowledged as a considerable aspect in designing information technology systems (*Ibid*, 141). By the mid-1980s, user-centredness was recognised as a major factor in successful system design (Gould and Lewis 1985, 301–302; Carroll and Rosson 1984, 9).

However, these user studies typically involved only the mediated perspective of the users in the design process, not the actual users themselves. However, as early as in the mid-1980s Gould and Lewis (1985, 301) recommended that design teams should have direct contact with potential users through interviews and discussions. This way designers could understand the goals the users have and the problems the users encounter (*Ibid*). Conversely, Carroll and Rosson (1984, 9) deemed interviews and discussions as indirect user involvement. For direct contact, the authors proposed that potential users participate in the design process by completing representative tasks or by troubleshooting errors (*Ibid*, 15).

In early usability testing, the goal was to motivate the discovery of a system that would best match the needs of potential users (Carroll and Rosson 1984, 9). Adapting user interfaces to the needs and expectations of the user group would improve the usability of the design (*Ibid*, 13). In practice, this meant that secretaries would not encounter a user interface intended for professional users (*Ibid*).

In sum, the importance of user-centred approaches has been a central consideration in usable design for approximately forty years. Whereas during this time usability has been a major concern for software systems, it has since been applied in the fields of documentation and hardware, as well. The targets of usability evaluation in the software domain range from the usability of website interfaces (Raka and Setyohadi 2021) to virtual reality user interfaces (Mäkinen 2018). In recent years, there has also emerged research on the usability of

hardware documentation, a topic frequently overlooked in usability studies. The topic has been discussed, for instance by Pöyhönen (2023), whose research was concerned with the applicability heuristic evaluation to hardware documentation.

3.2 Definitions

Any product designed for people to use should be useful and easy to learn and use (Gould and Lewis 1985, 300). These requirements for a system pertain to the concept of *usability*. The term has several definitions which vary according to the field and domain in which it is applied. According to Couper (2000, 385), “usable designs” are designs that are more than the users’ subjective reactions. In other words, usable designs include measurable outcomes, such as how long it takes to complete a task and the number and severity of errors (*Ibid*).

Another viewpoint in usability emphasises the interaction between humans and machinery. Such a view is present in Kuutti’s (2003, 13) definition, where usability is primarily concerned human-machine interaction. According to Kuutti, usability is a quality that assesses how fluently users employ the functions of a design to reach a specific, desired goal (*Ibid*).

Nielsen (2012) gives usability a twofold definition. On the one hand, it assesses how easy a user interface is to use (Nielsen 2012). On the other hand, usability “refers to methods for improving ease-of-use during the design process” (*Ibid*). Usability in the software context can thus be both a goal in itself in user interface design as well as a means for producing a design that is easy and pleasant to use. *Usability* in this definition is part of the wider concept of *user interface*: it is the qualitative attribute which describes how easy a user interface is to use or learn, among other things (Norman and Nielsen). A user interface is what the user sees and interacts with within a product – the functions as well as the visual aspects of the design (“User Experience”). In addition to software user interfaces, the term can refer to any physical hardware (Kuutti 2003, 13), which range from heavy machinery to hand tools and other everyday objects. Whereas usability is a quality of the user interface, the user interface, in turn, is part of the much-wider concept of *user experience*. As this research is concerned primarily with usability, I will not delve into the definition of user experience.

The definition of usability most relevant for this thesis is that presented in Nielsen's (1993) model of system acceptability attributes. In the model, usability is part of the wider concept of system acceptability (Nielsen 1993, 24). Nielsen's definition of system acceptability is concerned with whether a system meets the needs and requirements of its users and other potential stakeholders (*Ibid*). As the usability attributes are the main interest in this research, I have elected to take into consideration only certain aspects of Nielsen's model: the dimensions of usability. Figure 2 shows these dimensions.

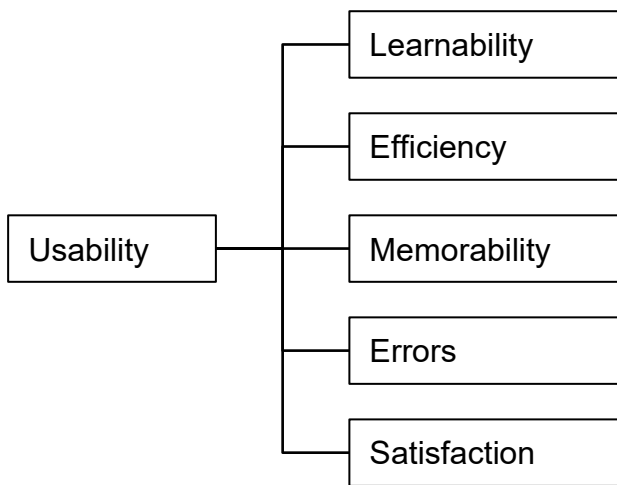


FIGURE 2. The dimensions of usability (adapted from Nielsen 1993, 25)

The dimensions of usability in Nielsen's model are learnability, efficiency, memorability, errors, and satisfaction. *Learnability* means that a system is easy to learn and that users can begin to complete tasks rapidly (Nielsen 1993, 26). *Efficiency* describes how efficient a system is to use: once the user has learned the system, she should be able to use it with a high level of productivity (*Ibid*). *Memorability* means that a user is able to return to the system without having to relearn it, even after a period of not using the system (*Ibid*). *Errors* refer to the number and severity of errors the user makes – the error rate of a system should be low, and the user should be able to recover from them (*Ibid*). Finally, *satisfaction* refers to the subjective experience the user has of the system: the design is agreeable and nice to use (*Ibid*).

Usability applies to all facets of a product which involve human interaction, such as installation, use, and maintenance (Nielsen 1993, 25). Usability can therefore also apply to the interaction which occurs between a user and a textual

system, as in the present study. From the information seeking viewpoint, learnability and memorability assess to how successfully users are able to navigate the document to fulfil their information needs. As discussed in section 2.3, efficiency in information seeking is closely connected to time-consumption: it determines how quickly users are able to find information. The number of errors describes how frequently users fail to find information or find information that is unsuitable for their needs. The definition of satisfaction is the same as that of Nielsen – how subjectively pleasant information searching in the document is.

In addition to the components in the model above, usability is closely connected to *intuitiveness*. Although intuitiveness is one of the fundamental and desirable qualities in human-computer interaction, the definition of intuitiveness remains vague (Turner 2008, 475). In the everyday sense of the word, intuitiveness refers to a process which requires little conscious thought (*Ibid*). Another definition defines intuitiveness in terms of previous experience – if a user has encountered a similar product or user interface before, he perceives it as intuitive and easy to use (Kuutti 2003, 13). In Kuutti's definition, intuitiveness is therefore closely linked to familiarity. One user can perceive a design to be entirely comprehensible because she has previous experience with a similar design (*Ibid*). Another user, in contrast, may find the same design entirely incomprehensible because he has no previous experience with similar products (*Ibid*).

According to definition above, intuitiveness is not an inherent quality of a system but a reflection of a singular user's expertise as regards similar systems. However, familiarity is not a requirement of an intuitive system. Turner (2008, 478, 480) notes that intuitiveness can also refer to designs which are based on "graspability, physicality and tangibility" or which make use of pre-existing action routines and social, cultural, or historical skills. Intuitiveness in such systems includes combining human senses or cultural knowledge in how users interact with designs. From the human senses viewpoint, intuitiveness can also be connected to the aesthetic qualities of a system. Aesthetic parameters include physical properties of a system a user can discern through his senses, such as appearance and composition (Naumann et al. 2007, 134). If users do not perceive the objects or signs of a system as attractive, usable, or familiar, they likely do not use the product intuitively (*Ibid*).

3.2.1 Users

A central related concept in usability research is the user. Different interpretations of the term *user* have been suggested during the information technology era, and in the previous decades the meaning has altered and morphed according to communities' needs (Kuutti 2001). For example, in information science, as I discussed in section 2.1, *user* can refer to information user – a person who needs, seeks, and uses information. As this definition suggests, the definition of user is frequently dependent how a user interacts with products. The European Integration (1993, 5) defines *user* as the person who uses, adjusts, maintains, cleans, repairs, transports, or decommissions a product. This definition defines the users according to their interaction with heavy machinery products and equipment.

When the products in question are text-based, the user of the texts is always also a reader (Suojanen et al. 2015, 49). Coney (1992, 58) refers to the users of technical documentation as *technical readers*. These readers are “rhetorical participants in the communication process” who interact with texts and receive predetermined information from them (*Ibid*). Technical readers are not interested in the intellectual basis of the text but on how the text can aid them in achieving specific goals (*Ibid*). These readers are goal-driven and primarily interested in information that they can apply to tasks rapidly and effortlessly (Suojanen et al. 2015, 30). As a result, technical readers use the texts in selective ways – they search only for the information which is relevant to the task currently at hand (Coney 1992, 58). The users in this study are the persons who employ the user manual in their everyday work tasks to find information in order to complete tasks. As stated in section 2.1, the users in this study are therefore also information users.

3.2.2 Usability and textual systems

In the contexts that I have thus far discussed usability, it typically refers to qualitative characteristics of a product or design. A product, however, does not necessarily denote a computer system or physical hardware. Suojanen et al. (2015, 14) note that almost any type of human activity can be assessed from a

usability perspective. This includes human-text interaction where users utilise texts to complete tasks. Nielsen (1993, 25) supports this viewpoint by stating that “usability applies to all aspects of a system with which a human might interact”. Although Nielsen uses the word *system* to refer primarily to software user interfaces, user instructions are an integral part of systems, devices, and products (Suojanen et al. 2012, 10). Utilising user instructions requires that a user interact with them to complete tasks.

In the field of technical communication, the term *product* denotes *information and communication products*, such as user instructions (Suojanen et al. 2012, 30). When the product in question is text-based, the usability of the product is closely linked to textual elements (*Ibid*, 49). In terms of usability, these divide into four components: legibility, readability, comprehensibility, and accessibility.

Legibility is linked to visual characteristics of the text, and it comprises typographical issues, page design, and information design (Suojanen et al. 2012, 50). A legible text is visually decipherable, meaning that the reader is able to see it and understand it (*Ibid*). The typographic issues that legibility is concerned with include font sizes and line lengths; the technical issues of legibility pertain to, for instance, document formats (*Ibid*). Of the aspects of legibility, information design is the most relevant to this thesis. Redish (2000, 163) proposes two definitions for information design: the process of developing a successful document and the overall manner in which information is presented on the screen or page.

Readability, in simple terms, refers to the style in which the text is written (Suojanen et al. 2015, 51). The style of writing consists of such aspects as word choices, sentence and paragraph length, and the use of active or passive voice (*Ibid*). Although readability can be measured as easily as by calculating sentence length, the content of the sentence must also be sensible and the text overall must be cohesive, logically structured, and terminologically consistent (*Ibid*).

Whereas readability is concerned with textual issues, *comprehensibility* pertains to the context and content of the text and how well the text fulfils its communicative function (Suojanen et al. 2015, 53). Comprehensibility is a more subjective quality than the two above, as something that is perfectly comprehensible to one person may be entirely incomprehensible to another. The

authors note that comprehensibility is closely related to the educational and cultural background of the reader.

A more holistic approach to texts covers not only the textual and technical qualities discussed above but also evaluates *accessibility* (Suojanen et al. 2015, 56). Although accessibility is often associated with users with special needs, such as those with visual impairments, accessibility as a concept is all-encompassing and does not refer to a specified user group (*Ibid*, 56–57). Despite the importance of the issue, I will not discuss the topic further in this thesis due to the scope of the concept.

In addition to legibility, readability, comprehensibility, and accessibility, the usability of texts can be linked to other aspects. As regards heavy machinery user instructions, the instructions should be as simple, concise, and clear as possible with manageable content modules that occur in logical order (Euroopan integraatio 1993, 9). In designing and producing user instructions, the primary guideline is that the text is understandable for the intended reader (*Ibid*, 10). This means that the writer of user documentation must consider the educational background and professional discretion that can be expected of the potential user (*Ibid*). In practice, this can mean that the writer avoids unusual occupational jargon (*Ibid*).

3.2.3 The effects of usability on business operations

Investing time and resources in the usability of a product has several benefits for a company. Although not always directly visible, increased usability of a product typically results in financial benefits (Nielsen 1993, 2–3). For instance, a usable user interface can reduce the number of user customer errors, which in turn reduces processing costs (Fisher and Sless 1990, as cited in Nielsen 1993, 3). Kuutti (2003, 16) suggests that especially increased efficiency has major benefits for a company. If a system has a considerable number of users, even a small usability problem that decreases efficiency can result in major costs over time (*Ibid*). Users and end-users also benefit from better usability, which can, again, cause economic benefits for the company. As customers save with better interfaces, the company receives a better reputation, which eventually results in increased sales (*Ibid*, 4).

As regards hardware in particular, a positive impact of usability is increased physical safety (Kuutti 2003, 16). Poor usability can result in frustration for the users, which increases the probability of errors and the risk of injury (*Ibid*). Increased proneness to errors can endanger the safety not only of the user but also of other persons and personnel. Frustration due to poor usability can also affect how users experience and interact with a product. From a documentation viewpoint, a user might become frustrated if he is routinely unable to find the information that he needs in a user manual. As a result, a person who, for example, maintains heavy machinery equipment might opt to contact maintenance support without even trying to find the information in the manual. In such cases, the frustration of an individual user may cause unnecessary burden for another department in the company.

Improving usability can reduce user frustration and thus improve satisfaction with a job or a system. Donahue et al. (1999) list a significant number of potential usability benefits in their article. These include increased job satisfaction for numerous parties associated with different organisations as well as users of designs (Donahue et al. 1999). This means that in addition to financial benefits, implementing usability guidelines improves the subjective experience of employees and users as regards designs. Another frequently occurring effect of usability according to the article is better productivity (*Ibid*). Productivity increases, for example, when users locate information faster or when they need to phone for more information more seldom (*Ibid*).

Despite the fact that companies frequently identify usability as an important aspect of successful system design, it is rarely tested in companies. Nielsen (1993, 5) states that although usability has several recognised benefits, managers may hesitate to implement usability methods because they perceive them as expensive and complicated.

In their study, Gould and Lewis (1985) identified five factors that discourage companies from recommending and following usability guidelines in practice. The first reason is that some designers simply do not believe that the recommendations for usability are worth following (*Ibid*, 303). On the other hand, the authors note that designers can confuse user testing, which involves actual users, with regular system testing. The third possible factor is that designers may fail to fathom the scope of their user base and therefore overlook usability testing

as inefficient. The fourth reason Gould and Lewis note deters companies from usability testing are beliefs as to what makes a design usable. This includes such beliefs as users should be able to reason their way through usability issues and that a good design is one that is flawless after the first iteration. Gould and Lewis' (1985, 305) fifth factor for dismissing usability guidelines is that some designers see it as added impracticality to the design process. However, as discussed earlier, this is not the case. The information technology market is vast, and consumers have a significant number of designs to select from when they make consumer choices. Implementing usability guidelines and producing designs that are pleasant for users therefore provide a company an edge in the competitive market.

3.3 Usability testing

Rubin and Chisnell (2008, 21) define usability testing as “a process that employs people as testing participants who are representative of the target audience to evaluate the degree to which a product meets specific usability criteria”. The testing participants are ideally real users who can provide direct information on how they use a product and what kind of problems they face in completing tasks (Nielsen 1993, 165). The objectives of usability testing include eliminating design problems and frustration and improving profitability (Rubin and Chisnell 2008, 22). The keyword in usability testing is to *improve* a product, not to detect all possible problems associated with it (Koskinen 2005, 188). In this study, I focus on the usability problems in the product manual that users report affect information seeking.

Different groups of researchers employ different methods to evaluate usability, and these groups approach the concept with different focal points in mind (Sullivan 1989, 258). The most frequent methods of usability testing are user tests and heuristic evaluation. In a user test, a test group who represent the real users of the product complete tasks that are as close to actual tasks as possible (Koskinen 2005, 188). In heuristic evaluation, one or several experts evaluate the usability of a design with the help of usability principles (Suojanen et al. 2015, 77). In practice, the evaluators compare the design to the selected

set of heuristics and assess how well the design fulfils the requirements of the heuristics.

Although user testing and heuristic evaluation are the most frequently employed methods of usability testing, other possible testing methods also exist. The method employed depends on the aims of the research. Sullivan (1989, 259) groups the methods of usability testing into three categories: observation, traditional evaluation methods, and direct questioning. User testing belongs to the first category, whereas heuristic evaluation belongs to the second category.

Direct questioning methods include surveys and interviews which aim to reveal information about the users' thought processes and feelings (Sullivan 1989, 259). Surveys and interviews can provide information about users' responses and attitudes towards a product as well as their learning and judgements (*Ibid*). Because of these potential outcomes of the method, I opted for an interview as the research method in this study. Section 4 provides a detailed description of how I employed this method.

Despite direct questioning having advantages as to what it can reveal as a usability research method, Nielsen (2012), deems focus groups, for instance, to be poor methods for evaluating the usability of interaction designs. Regardless of Nielsen's conception, I selected a focus group discussion for the method of research. Nielsen is primarily concerned with software user interface testing, whereas the target of the present study is not such. The goal of this study is to assess usability based on users' experiences, which positions this study between the realms of usability testing and user experience research.

3.4 Summary

Usability and usability testing have been important quality considerations in software system design for several decades. The importance of usability became to be recognised especially in the 1980s when the market for personal computers began to expand. As a result of the shift in the user base of computers, companies were faced with the requirement of responding to the needs of different users. Although the roots of the usability of user documentation are firmly planted in the software domain, research has emerged in recent years on the usability of hardware documentation, as well.

Over the decades, usability has garnered a variety of definitions depending on the context to which it has been applied. In a general sense, usability refers to a set of quality attributes a system possesses. As a design perspective, usability positions the users of a design at the centre of the design process (Couper 2000, 385). One widely accepted more specific definition of usability is from Nielsen's 1993 model of system acceptability. In the model, usability consists of five different dimensions: learnability, efficiency, memorability, number of errors, and satisfaction. These facets together determine how easy a system is to use. Although usability is traditionally considered to be a set of qualities of software user interfaces, Suojanen et al. (2015, 14) state that any human activity can be considered from the usability point of view. Therefore, texts, such as user documentation, are also a viable target for usability evaluation. The facets of usability in textual systems include legibility, readability, comprehensibility, and accessibility (Suojanen et al. 2015, 49–57).

As mentioned above, users are at the heart of the usability design process. The definition of user depends on the context currently at hand. In the case of textual systems, the users who interact with the systems are readers. Regardless of the medium of the system in question, users are, in essence, the people who interact with systems.

There are several methods a researcher can employ when conducting a usability test. The most common methods are user tests and heuristic evaluation, which reveal information on how users operate systems and where they encounter difficulties. Other testing methods include direct questioning methods, such as interviews. Interviews can reveal information on users' attitudes and feelings (Sullivan 1989, 259), which makes them a feasible method of usability testing.

4 METHODS AND MATERIALS

In this section, I discuss the research methods and materials which I used in this thesis. I begin by presenting the research method which I employed to collect the data. I then further describe the research material and the approach I employed to categorise relevant instances in the material.

4.1 Semi-structured focus group discussion

The method I selected for collecting the research material was focus group discussion, a form of qualitative research interview. A focus group discussion gathers users together to discuss concepts and identify problems (Nielsen 1993, 214). In a focus group discussion, the role of the interviewer is not to guide the discussion but to facilitate the discussion of the interviewees (Brinkmann 2014, 286). The facilitator thus leads the group and maintains the focus of the group on issues relevant to the discussion (Nielsen 1993, 214).

The interview format of the discussions was semi-structured with open questions. I selected a semi-structured interview format for this study because it is applicable for collecting data that emphasises users' experiences. Open questions, in turn, allow the participants to express themselves freely without attempting to force them to select answers from predefined categories (Williamson 2018, 385). A semi-structured interview is also well suited for a focus group discussion because "a focus-group session should feel free-flowing and relatively unstructured" (Nielsen 1993, 214). Compared to a structured interview, a semi-structured interview permits more flexibility for the direction of the discussion as the themes raised by the participants can spontaneously be taken as topics (Brinkmann 2014, 286). Another advantage in a semi-structured interview is that, compared to an unstructured interview, the researcher can focus the discussion on issues she considers important to the research project (*ibid*).

Although a focus group discussion is suitable for collecting information on users' experiences, as a research method, it is not infallible. Heinonen (2023, 13) notes that the researcher must have a certain level of knowledge of the domain in order to facilitate the discussion in the interview. Additionally, Nielsen (2001) suggests three possible disadvantages to interviews as a user testing method. The first disadvantage is conformism: participants in interviews might respond according to what they believe the facilitator wants to hear or modify their answers to be more socially acceptable (*Ibid*). The second possible problem is the unreliability of the human memory, as the participants in interviews do not discuss what they do but what they remember doing (*Ibid*). The third issue is that when people report what they do, they tend to rationalise their behaviour (*Ibid*) This may lead the participants to report reasons for their actions that had not in fact occurred in actual situations (*Ibid*).

Regardless of these potential drawbacks, a semi-structured focus group discussion was an appropriate method to collect the material. As noted by Sullivan (1989, 259), direct questioning, such as an interview, aims to reveal information about the users' thought processes and feelings. Interviews can also reveal information about users' attitudes towards a product (*Ibid*). As regards the knowledge required of the researcher, I became acquainted with the product manual in question during my internship at the company. In addition, to ensure that the discussions remained on relevant topics, I was assisted in the interviews by another facilitator on behalf of the company.

I formulated five questions for the discussions that would allow me to collect information relevant to my research questions. To facilitate the discussion, I included additional questions for each of the five primary questions. The purpose of these additional questions was to help the participants describe their thoughts and experiences. All the questions were presented on PowerPoint slides for the participants during the discussions. The table that follows shows all the questions included in the discussions.

TABLE 1. Discussion questions

Number	Primary question	Additional questions
1	In what kind of situations do you require information outside of the tendering or order configurator?	Refers to situations where you must seek additional information to perform a work task.
		What kind of information do you typically need in such situations?
2	The information seeking process: how do you seek information?	From whom or where do you seek information?
		What factors influence where or from whom you seek information?
		What kind of thoughts or feelings does the information seeking process evoke in you?
		Do you encounter situations where a colleague, for example, asks you for information?
3	What is your experience with the product manual in information seeking?	In what kind of situations do you use the product manual?
		How do you search for information in the product manual?
		Do you feel that the product manual responds to your information needs?
		What kind of thoughts or feelings does using the product manual evoke in you?
4	What factors, in your experience, prevent or hinder using the product manual?	Give reasons as to why you would rather seek information in some other source.
5	In your opinion, how could the product manual be improved to better respond to your information needs?	What do you think would improve the findability of information?
		What do you think would make the product manual more approachable?
		What do you think would be a suitable format for presenting the information in the product manual?

Of the questions in table 1, questions 1–3 pertain to the information seeking processes of the users, whereas question 4 and 5 are concerned with the

usability of the product manual in information seeking. Question 1 aimed to discover the users' information needs. Question 2 concerned the steps the users take when they need to address their information needs. This includes the potential information sources the users can consult and the reasons as to why they choose a specific source, for example, a human source. The purpose of question 3 was to discover what kind of information needs the users seek to fulfil with the product manual in particular. At this point, I was also interested in the users' information searching strategies in the product manual and their experiences as to how well the product manual meets their requirements. Question 4 was concerned with the reasons as to why the users prefer to seek information in the product manual regardless of the information being included in the manual, as well. Here, the purpose was to discover if the usability problems of the product manual deter users from utilising the document and what kind of concrete impacts the usability of the product manual has in the users' workflow. Finally, with question 5, I wanted to determine if the users have specific desires as to how the usability of the product manual could be improved and to which usability problems these improvements primarily pertain to.

4.2 Research material

The research material in this thesis consisted of three focus group discussion transcripts. I collected the material at a heavy machinery company which operates in the industrial engineering and manufacturing sector. The primary purpose of the discussions was to gather information relevant to my research questions (see Introduction). The relevant information pertained to the users' information seeking processes and their experiences with the product manual in information seeking.

I conducted two of the discussions on-site at the company and one remotely in Microsoft Teams due to scheduling conflicts. The time allotted for each discussion was two hours. I recorded each interview with the recording function in Microsoft Teams and produced preliminary transcripts of the audio files with the transcribing function in Microsoft Word. I only transcribed the parts of the recordings where the discussion was on information relevant to my research questions. Therefore, the time stamps where the users discuss unrelated issues

are marked in the transcripts as such. After producing the preliminary transcripts, I reviewed them and corrected the errors made by the transcribing function. Because I conducted the discussions in Finnish, I translated the extracts I selected for the analysis into English. To aid with the translation, I utilised the DeepL neural machine translator.

From the transcripts, I have omitted or pseudonymised all personal information about the users and information on the company or its products. I destroyed all personal information about the participants as well as the discussion recordings after I had transcribed them.

The participants in the discussions are real users of the product manual from different parts of the product development process. In total, eight users of the product manual participated the discussions. Each user filled a research consent form before participating in the discussions. Table 2 shows which discussion each participant attended as well as his or her field of work and level of experience.

TABLE 2. The participants in the discussions

Discussion	Participant	Field of work	Level of experience
I	A	Domestic sales	Experienced
	B	Domestic sales	Novice
	C	Domestic sales	Experienced
II	E	Order processing	Experienced
	F	Order processing	Experienced
	G	Product development	Experienced
III	H	Tender support	Experienced
	I	Product development	Experienced
I–III	D	Documentation	Experienced
I–III	Facilitator 1	Researcher	-
I–III	Facilitator 2	Documentation	Experienced

The users in discussion I are tendering engineers, whereas the users in discussion II are design engineers. Of the two users in discussion III, one is a tendering engineer and the other a design engineer. These two groups also form the user groups in this study. A user is considered experienced if he or she has more than five years of experience with the product line in question. Participant

D is part of the documentation team and is responsible for maintaining and updating the product manual. She participated in all discussions from a position of interest, assuming the role of active listener rather than an interviewee.

Chafin (1982, 36) divides users into four categories on a continuum from beginner to experienced: naïve, novice, competent, and expert users. These groups of users have different documentation needs which depend on their level of experience (*Ibid*). Naïve users have virtually no prior knowledge as to how the system operates (*Ibid*). Novice users are those who have some theoretical knowledge of how the system operates but do not know how to use it (*Ibid*). Competent users have both theoretical and practical knowledge of the system – they know how the system operates and how to operate it (*Ibid*). Expert users know the theoretical basis of the system so well that they can operate it without further effort (*Ibid*).

Of the total number of participants in the discussions, seven are experienced users and one is a novice user of the product manual. I refer to experienced users as those who have more than five years of experience with the product manual. Although Chafin (1982, 36) defines *novice users* as those who lack knowledge on how to operate a system, I use the term to refer to those who have less than five years of experience using the product manual. Therefore, a novice user can have both theoretical and operational knowledge on the *product* but lack experience with the product's *documentation*.

4.3 Qualitative content analysis

The tool I used to analyse the research material was content analysis. Content analysis is applied to identify, quantify, and analyse specific themes or concepts within a set of qualitative data (“Content analysis” Columbia University). Via content analysis, a researcher can make inferences about the messages in the research material (*Ibid*), in this case, the users’ experiences towards information seeking and the product manual.

In terms of the theory of science, qualitative content analysis mediates between a constructivist and positivistic position (Mayring 2021, 21). The former position denies “an independent objective reality” and focuses on interpreting subjective viewpoints, whereas the latter aims to measure variables and

construct “objective theories of the real world” (*Ibid*). The mediating position of the method therefore suggests that the target of analysis can be, on the one hand, the subjective reality of an individual, which contributes to constructing “a socially shared quasi-objective reality” (*Ibid*, 20).

Qualitative content analysis was developed from its quantitative counterpart for evaluating large amounts of – typically textual – material (Mayring 2021, 48). To construct quasi-objective realities from large sets of research material, qualitative content analysis utilises category definition. There are two different strategies for forming categories: inductive category formation and deductive category formation. In inductive category formation, the research findings emerge from the frequent and significant themes in the research material without restraints from structured methodologies (Thomas 2003, 2). Deductive category formation, on the other hand, aims to extract a specific structure from the material (Mayring 2021, 88). In other words, the categories under investigation are formed in advance through, for example, a certain methodology or theoretical framework and are then applied to the material at hand.

The approach I adopted in the categorising the material is inductive in nature. According to Thomas (2003, 2), the inductive approach is concerned with condensing extensive material into a briefer format, establishing links between the aims and findings of the research, and developing a model for the underlying structure evident in the material. The categories and instances relevant to this study emerged from the discussion transcripts. I compared these categories to the research questions in order to establish connections between the research objectives and findings. In category formation, I also utilised the set of questions proposed by Wilson (2006, 662; see Section 2.2) with which information needs research is concerned: why users seek information, what purpose does the information serve, and how users employ the information. Through these findings, I aimed to discover underlying reasons for the users’ information seeking behaviours and for their experiences towards the usability of the product manual.

4.4 The course of the analysis

To conduct the content analysis, I utilised the three-stage process to analysing qualitative data as described by Hirsjärvi and Hurme (2022). This process

consists of describing, classifying, and combining. The departure point of the analysis is to describe the research material, which provides the basis for further analysis. Describing the material means identifying the features or characteristics of relevant instances (Hirsjärvi and Hurme 2022). This stage typically produces answers to questions such as *who*, *what*, *how much*, or *how often* (*Ibid*). In the descriptive stage, I first familiarised myself with the material by reading the transcripts while listening to the recordings multiple times. I then produced descriptions of the contents of the analysis relative to the research questions. The descriptions pertained to what kinds of overarching issues or themes were discussed as regards information seeking or the usability of the product manual. I also determined how frequently these themes emerged and in what kinds of situations did the users report encountering them.

The third stage of qualitative analysis entails combining the material. This stage consists of combining the products of the first two stages (Hirsjärvi and Hurme 2022). The purpose is to find similarity and consistency between the relevant instances in the material (*Ibid*). Due to the breadth of the research material, in this stage I focused only on the most frequently occurring items per theme when classifying the material. I gathered the most frequently recurring items that emerged during the previous stages and formed categories based on their themes. These categories include:

- the user's information needs
- the user's information sources and information seeking strategies
- the usability aspects of the product manual
- possible improvements to the usability of the product manual.

The analysis section is structured according to the categories listed above. In addition to classifying the material, this stage included determining the connections between the categories, for instance, how the users' information seeking strategies are related to the usability issues of the product manual.

5 THE USABILITY OF THE PRODUCT MANUAL IN THE INFORMATION SEEKING PROCESS

In this section, I describe the information behaviours of the users of the product manual and the usability of the product manual in the information seeking process. I first briefly describe the information needs of the users. Information needs in this analysis emerge in situations where the tendering configurator or order configurator does not provide the information that the users require. In the second section, I address the information seeking strategies that the users employ to fulfil their information needs. I then discuss the usability of the product manual in information seeking based on the users' reported experiences. The final section addresses possible alterations that could improve the usability of the product manual in information seeking. Throughout the analysis, I illustrate the discussion with extracts from the research interviews.

5.1 Information needs

As contextual information, I identified from the research data the most frequently occurring information needs of the users in this study. I conducted the analysis using the same method, described in section 4, that I used for the subsequent analysis. However, I do not include the entire section on information needs in this analysis due to the scope and limitations of this study. Instead, the table below shows the concise key findings of the information needs analysis.

TABLE 3. The most frequent information needs according to user groups

Category of information need	User group	Examples
Routinely required information	Tendering engineers	Information on the compatibility and replaceability of components
		Information on the material selections of a product
	Design engineers	Numeric component information, such as information on the dimensions of a component
Specialised information	Tendering engineers	Information on products designed for unfamiliar or specialised industrial processes
	Design engineers	The requirements of technical standards

As the table shows, the most frequently occurring categories of information needs for the users can be divided into *routinely required information* and *specialised information*. The former refers to information the users require in their work task frequently and therefore seek frequently. The latter refers to information that is outside the users' expertise or information that the users may not remember because they require it infrequently. I use the collective term *specialised information* to refer to both types of information.

Based on the research material, there were no evident differences between the types of information needs between novice and experienced users, but some differences emerged between the user groups. Whereas for both groups, routinely required information typically involves information on product components, the tendering engineers seek information on the compatibility and replaceability of components more frequently than the design engineers. In contrast, the component information design engineers often require is numeric and pertains to the dimensions or measurements of components. In addition to component information, the tendering engineers frequently require information on the material selections of a product.

Whereas the category of routinely required information contained similar information for both user groups, there were clear differences as to what

specialised information is for the two groups. In the tendering process, specialised information most frequently involves information on products designed for industrial processes with which the users are unfamiliar. For the design engineers, however, specialised information often pertains to the requirements of technical standards which the users must consider in the design process.

The likely motive for the users to routinely seek information on the product components is that the information is difficult to memorise. There are two probable reasons for this. Firstly, the product line in question is highly modular and customisable. In the tendering process, the users have various combinations to select from according to the requirements of the customer. Because of the large quantity of information, the users are unlikely to be able to memorise all the information they may require.

Secondly, the users may have difficulty memorising component information because of the quality of the information. In the design process, the users consult tables and technical drawings to determine, for instance, component measurements and technical limits. The information that the drawings, for example, provide is highly numeric, and therefore not the type of information the users are likely to learn by heart. In addition to the nature of the information, the quantity of information is, again, considerable. These two factors suggests that it is unlikely that the users would be able to memorise the information, at least not in any exhaustive sense.

Similarly, the memorability of information prompts the design engineers to seek information on the requirements of technical standards – indeed, one user commented that the reason for seeking such information is because it is difficult to memorise. However, memorability in this case is not affected by the quantity of information but rather the fact that the information is required infrequently. Likewise, the fact that the tendering engineers require information on specialised industrial processes infrequently affects the memorability of the information. Additionally, such information may be beyond a user's expertise, which is why he is required to seek it elsewhere.

5.2 Information seeking behaviour

Information seeking in this analysis consists of two components: information sources and the strategies of information searching that the users employ to fulfil their information needs. The two information sources the users in this study utilise in information seeking are human sources and the product manual. The primary information source is the product manual, the main function of which is to provide information for its users on the specific product line. The types of information that the users seek from these two sources are summarised in the table below.

The information source and strategy of information searching a user selects varies according to the user's current information need. The users typically seek information in the product manual when their information need pertains to product components or technical or numeric data. Human sources, on the other hand, provide additional, specialised, or in-depth information on a topic.

For the purposes of this research, I have excluded from this discussion information that the users seek in sources other than the product manual because the manual does not contain it. Instead, when I discuss seeking information from human sources, the information in question is such that it does exist, at least to a certain extent, in the product manual, but the users seek it elsewhere regardless.

5.2.1 Human sources

Information seeking from human sources occurs primarily between the users and their colleagues, or between the users and members of other teams. There are two major reasons for why the users seek information from human sources instead of or in addition to the product manual. Firstly, the information the users acquire from human sources can support and complement the information in the product manual. In these cases, the information that the users require pertains primarily to the category of specialised information. In situations where the tendering engineers, for instance, configure products for industrial processes with which they are unfamiliar, they tend to rely on the expertise of experienced colleagues. Human sources in these situations are the preferred method of seeking information for the majority of the users, regardless of the user group.

When asked what may cause the users to seek information from colleagues, one user commented:

(1) **Osallistuja F**

Joku kokemusperäinen (.) parempi tieto.

Facilitoija 1

Koet sä sen kollegan tiedon siinä kohtaa luotettavammaks ku sen mitä tuotemanuaalissa on?

Osallistuja F

En välttämättä luotettavammaksi mut ehkä saattaa saada niinku jotain syventävämpää tietoa ku mitä tuotemanuaalissa on.

Participant F

Maybe experience-based (.) better knowledge.

Facilitator 1

Do you find information from a colleague to be more reliable in such situations than the information in the product manual?

Participant F

Not necessarily more reliable, but you might get information that is more in-depth than that in the product manual.

The user states that in some cases, he finds information from an experienced colleague to be better than the information in the product manual, but further clarifies that *better* does not necessarily mean *more reliable*. This suggests that when the user requires information on an unfamiliar topic, he presumes that the information in the product manual is insufficient for his needs. As a result, the user believes that information seeking is more likely successful if he directly refers to a human source.

During the discussions, the users described several instances where the information from one source alone is deemed insufficient. One user stated the following when asked why he seeks information from human sources although the required information is available in the product manual:

(2) **Osallistuja G**

Ja tietysti jotku asiat on sit helpompi selvittää suoraa suunnittelijalta että vaikka se siellä tuotemanuaalissa on. Tuotemanuaalista on hankala välillä kysyä että minkä takii se on näin.

Participant G

Some issues are easier to find out directly from the designer even if it were stated in the product manual. You cannot ask the product manual why something is as it is.

In extract (2), the user comments that sometimes the information provided in the product manual is too generic for his needs. In his experience, the product manual rarely gives the reasons behind the information the document contains – the manual primarily offers technical data and facts with little background information. Formulating the data into information that has relevant connections to related topics is then the user's responsibility. To aid formulating the data into relevant information, a product designer, for example, can provide detailed information which complements the information in the product manual and therefore aids the user's understanding of the subject. The user therefore requires complementary information in order to form meaningful connections of the data in the product manual.

However, the same user also reported that he is not always certain whether the complementary information he requires is included in the product manual but opts to seek information elsewhere regardless. Seeking information from human sources in favour of consulting the product manual may, in such cases, result from two causes: the breadth of the product manual or the preconceptions the user has about the information in the document. The product manual in its linear documentation format includes almost 900 pages, which can obscure the users' understanding about the range of information it covers. For instance, when asked in what kind of situations the user seek information outside the product manual, one user responded:

(3) **Osallistuja I**

No jos- joskus voisi olla vaikka sellainen että ei vaa osaa ajatella et tääki löytyy tuotemanuaalista.

Participant I

Sometimes it might be that you just don't know that you can find this in the product manual.

In extract (3), the user acknowledges that the scope of the product manual affects the users' information behaviour. Users may be aware that the product manual provides a large quantity of information, but the quantity of information may obscure the actual scope of information in the manual.

In addition to the scope of the product manual, certain presumptions about the information in the product manual may result in the user automatically seeking information from human sources. As suggested by extract (1), users may presume that the information in the product manual is insufficient for their needs. In such cases, the users may know that they need detailed information about the issue at hand. However, perhaps based on earlier experience, they presume that the product manual only contains generic information on the subject. This preconception about the contents of the product manual causes the users to prioritise human sources.

The importance of complementary information was especially prevalent in the comments of a novice user. The user commented that the topics discussed in the product manual are new and unfamiliar to him. Therefore, before the user consults the product manual, he seeks information from human sources. This strategy allows him to gain a comprehensible and complete understanding on a topic before searching for related data. This suggests that the lack of context or background information makes the product manual less usable for novice users as they are required to seek additional information elsewhere.

The users consult human sources also in situations where the information in the product manual is difficult to understand. Whereas difficulty understanding the information in the product manual was not as common a theme as insufficient information, it did emerge as a factor that affects information seeking. One experienced user commented on the matter as follows:

(4) **Osallistuja H**

Et et niinku tuntitolkulla en kyllä ite sitä tuotemanuaalia lue et jos ei se siit rupee jossain tietyssä ajassa selviimään ni sitte kyllä niinku hakee vähintää jonku muun lukemaan siitä yhdessä tai sitte kysyy joltaa joka sen oikeesti niinku muistaa tai tietää heti että miten asia on.

Participant H

I will not read the product manual for hours and hours so if I cannot make it out in a certain amount of time, I get someone else to read it with me or ask someone who actually remembers or knows right away how it is.

The user comments that she seeks information from human sources after she fails to interpret information in the product manual. Here, consulting the product manual is the primary information seeking strategy for the user. However, should the information prove difficult to understand, the user interrupts the information seeking process in the manual to consult to a human source.

The insufficiency and poor comprehensibility of information discussed in this section are closely connected to the usability of the product manual, a topic into which I delve further in section 5.3. To sum up the discussion so far, there are prominent factors that cause the users to seek information from human sources. The users may feel that the information in the product manual is inadequate for their needs or difficult to understand. The users thus seek additional information from human sources. The information the users acquire from human sources often supports and complements the information in the product manual. Therefore, information from human sources helps the users understand the context behind the technical data in the product manual.

5.2.2 The product manual in information seeking

Although the product manual alone does not always provide a sufficient amount of information, based on the comments of the users, the document is regarded as an important tool in the information seeking process. One user described the product manual as the most important tool in his department because it contains almost all the information that he might need in his work tasks. Indeed, as an information source, the product manual has some specific uses for which its users employ the document. The information that the users typically seek in the product manual is highly related to the first category of

information needs: information that the users seek routinely but which is difficult to memorise. The product manual provides highly technical information that the users need in their work tasks. The users likely acknowledge that if they require technical information that is difficult to memorise, the simplest way to acquire the information is from the manual. That is, the information is such that if the users cannot memorise it, they acknowledge that their colleagues, for instance, are unlikely to have memorised it either.

The users reported several reasons why they may seek information in the product manual instead of from human sources. In some cases, the information is more readily available in the product manual. The product manual is also a primary information source for both tendering and design engineers when they require information on the components of the product. In the tendering process, the users frequently forward information on the product configuration to some other party, and in such cases, the forwarded information is typically the information the users can find in the product manual. The users also frequently employ the product manual when they are uncertain of a matter or want to confirm the validity of information. One experienced user commented on this last matter as follows:

(5) **Osallistuja H**

– – mul on siis tuotemanuaali aivan koko ajan auki ni kyl mul herkästi jos joku kysyy mult jotain mie luultavast tiedän sen mut sit mie myös avaan sen tuotemanuaalin ja viel varmistan – –

Participant H

– – I have the product manual open all the time, so if someone asks me something, I probably know the answer, but I also open the product manual and confirm it – –

The user commented that, although she has a strong familiarity with the product line in question, she frequently confirms from the product manual information that she forwards to other users. Confirming information occurs both for experienced users, as in extract (5), and for the novice user. The novice user commented that he frequently confirms information related to the product components from the product manual because he is unfamiliar with the product configurations. Whether a user confirms information with which he is familiar depends on the

personal preferences of each individual user – some people prefer to verify information more frequently than others.

Confirming information from the product manual is related to another factor which prompts the users to seek information in the manual. Occasionally, there might be information in the tendering or order configurator which contradicts the information in the product manual. In such cases, the users reported that they find the information in the product manual to be more reliable than the information in the configurator. Overall, when the users encounter information in the configurator that is not in accordance with the information in the product manual, they are more likely to accept the information in the product manual. One user from the tendering process expressed his opinion on the reliability of the product manual, albeit tentatively:

(6) **Osallistuja D**

Eli sä luotat enemmän tuotemanuaalin tietoo kuin tarjouskonfiguraattorin tietoo?

Osallistuja A

No tavallaa. Emmie sitä oo sillee ajatellu että kumpa- kumpaa on enemmän mut kyl kyl tavallaan niinku uskon enemmän sitä tuotemanuaalia kyllä ku tarjouskonfiguraattoria.

Participant D

So you trust the information in the product manual more than the information in the tendering configurator?

Participant A

Well sort of. I have not really thought about which one is more but I think I trust the product manual more than the tendering configurator.

The user commented that he has not thought about which source he believes to be more reliable in situations that involve contradicting information. The user also remarks, however, that he does believe the information in the product manual is more reliable.

The reliability of the product manual is at least partly related to the users' perception of the document. The users regard the product manual as a source of information where the provided information is essentially correct. One user commented on the reliability of the product manual as follows:

(7) **Osallistuja H**

– – ajatusmallina se et se on se raamattu jossa ne asiat pitää olla oikein. Totta kai se se täytyy olla oikein myös tarjoustyökalussa ettei kukaa vahingos valitse vaa semmosia mitä ei saa mut että niin kun se, se tuotemanuaali on se raamattu.

Participant H

– – the idea is that it is the bible where the information has to be correct. Of course, it must also be correct in the tendering tool so that no one accidentally selects something that is not available but, as it is, the product manual is the bible.

The user in extract (7) says that, as a rule, information in the tendering configurator should be correct so that the users cannot select product configurations that are unavailable. However, if users require information to support the configuration process, the source they can ultimately trust to provide correct information is the product manual. This attitude reflects the role of the product manual as the credible, primary source of information.

So far, I have discussed the fact that the product manual contains a large quantity of information in linear documentation format. I have also touched on the fact that the breadth of the product manual affects the users' information seeking behaviour. Users reported that information might be difficult to find, which prompts them to seek it elsewhere. Nonetheless, I have thus far refrained from discussing the concrete steps that users take when they search for information in the document. How do the users actually search for information in the product manual?

The two information searching strategies that emerged in the discussions were to use the Find function (Ctrl-F) shortcut and title-based navigation. The former is by far the most common strategy to seek information, as seven out of eight users reported using Ctrl-F routinely. The Ctrl-F function enables users to search for terms or longer strings of text within the document. In title-based navigation, the users navigate the product manual via the Bookmarks panel or table of contents of the PDF document. As a strategy of information searching, title-based navigation was not as common among the users as the Ctrl-F shortcut. Both of these strategies can be highly efficient for the users in information searching because they allow the users to browse the document faster and directly to search for relevant content.

Although both common strategies, using Ctrl-F and title-based navigation are not entirely infallible and uncomplicated to use. The use of Ctrl-F, for example, was reported to entail two problems: the number of search results and the operating principle of the search function. Because the document is so extensive, Ctrl-F often produces a substantial number of search results from which the user has to navigate to the correct one. Several users commented that the number of results Ctrl-F produces is inconvenient in terms of information searching. Browsing through the results is time-consuming and may, because of the size of the document, not considerably decrease the amount of information the user has to sort through.

In addition, Ctrl-F does not necessarily guide the user to the correct information. Successful use of Ctrl-F requires that a user knows the exact search term or wording for the topic that he wants to find. One user commented on this issue as follows:

(8) **Osallistuja I**

No se on melkee ko- just kokeilemalla sillee että tota suurin piirtein tietää mitä sanaa on käytetty mut sit jos ei sil löydy ni sit ehkä ettii se just niinku synonyymin sille että. Mut ihan hyvin on sillai kyl toiminu että kyl mie oon aina löytäny sit jos se vaa on tuotemanuaalissa.

Participant I

It is usually just trying it out, I usually roughly know what the term that has been used but then if I cannot find information with it then I try to find a synonym for it. But it has worked quite well, I have always found information with it if it is included in the product manual.

The user commented that he might not know the exact search term, but he is typically able to find information via Ctrl-F. Several users recognised the requirement of precise terminology as a hindrance to the use of the Find function. Whereas experienced users reported having trouble with the issue, the terminology aspect of Ctrl-F was most prominent in the comments of the novice user. Due to his inexperience with the product manual, the user does not necessarily possess the terminology required to successfully navigate the document. The issue of unfamiliarity with terminology was reported less frequently by experienced users, probably because familiarity with the document creates familiarity with the terminology used in it.

Another aspect relevant to this issue of terminology are the languages used in the workplace. The tendering engineers in domestic sales reported that they use Finnish when conversing with one another. However, the majority of product documentation is written in English. The users reported that if they discuss a certain aspect of the product with a colleague, it is likely they use Finnish terminology. However, when they need to search for the same information in the product manual, they may be unfamiliar with the corresponding English terms. Overall, from a textual viewpoint, the users generally considered the contents of the product manual to be easy to use. Nevertheless, searching for the English or Finnish equivalents of terms was a factor which the users reported to hinder information seeking.

As regards title-based navigation, the most frequently reported problem pertains to the opaqueness of the headings in the document. Several users commented that the headings do not always provide clear descriptions of their textual content. As a result, the users search information via title-based navigation through trial and error. One experienced user described the trial-and-error process as follows:

(9) **Osallistuja A**

Mie oon aina lähtenyt sieltä niinku et sisällysluettelosta ja sit ahaa ei ku tuo menee väärää polkua lähetääs uudestaa, tuo menee, tuo menee väärää polkua, et on ollu niinku hankala löytää.

Participant A

I have always started from the table of contents and then, oh, that goes the wrong way, let's try again, that goes the wrong way, so it has been hard to find.

Successful navigation via the table of contents or Bookmarks panel requires that the user know what kind of information is located under which heading. Because of the opaque headings, the users must rely on their existing knowledge of the document's contents to find information. Alternatively, they can use tentative search paths, as the user in extract (9) reported doing.

Above, I discussed the factors that affect how successfully the users find information via the Ctrl-F function or title-based navigation. Whereas both strategies have restrictions, the restrictions do not appear to have a major

influence on selecting the information searching strategy. Regardless of the problems associated with Ctrl-F, it was by far the preferred method of navigating the product manual. This is because the users consider Ctrl-F to be the more efficient strategy of the two. In cases where the users do not know the correct search term, they likely know a term close in meaning to the intended term. In other words, the users can attempt to find the information using synonyms or related terms. In title-based navigation, the users may need to do a considerable amount of browsing before they find the information they need. Although browsing the results of the Ctrl-F search is time-consuming, the users feel that it is not as arduous as browsing the document via the headings.

Another reason why the users frequently utilise Ctrl-F is related to the opaqueness of the headings. Successful use of title-based navigation depends on the user's knowledge on or experience with the document's contents. The user must be able to anticipate what kind of information is located under which heading. Ctrl-F is the strategy the users might resort to after they fail to find information via title-based navigation. As one user stated:

(10) **Osallistuja B**

Se on se sisällysluettelo jotenki hyvinki harhaanjohtava. (.) Sitä ei tarvi ku muutaman kerran kliknutella ni sit tulee sellainen pieni epätoivo että eh-eihän täällä ole mitään ja sit control f.

Participant B

The table of contents is quite misleading. You only have to click it a few times before you get desperate because there is nothing there and then use Control F.

The user feels that the table of contents in the product manual is rather opaque, as the headings do not give sufficient clues as to the contents of the sections. The table of contents becomes the more convenient the more experience a user has with the contents of the document. There appears to be a consensus among the users that successful information seeking depends on the level of experience of the user. This suggests that users must remember what kind of information is under each heading instead of the headings being sufficient indicators of their contents. I discuss the memorability of the product manual in closer detail in the subsequent sections.

In summary, the product manual has some specific uses for which the users utilise it in information seeking. Firstly, in cases where the users' information needs involve information that is frequently required but difficult to memorise, they typically consult the product manual. Secondly, the users consider the information in the product manual to be highly reliable. For example, in cases where users are uncertain of something or encounter contradictory information between two sources, they ultimately rely on the information in the product manual.

The users have two strategies with which they search for information in the product manual. The more frequent strategy is to use the Ctrl-F function in the document. In this strategy, the user searches for matching strings of text in the document. The less frequent but still widely used strategy is title-based navigation where the user browses the document via its table of contents or the Bookmarks panel. Although both strategies are frequently utilised, they have certain restrictions. The Ctrl-F function requires the users to know the exact term or wording of the search target. Title-based navigation, in turn, requires that the users have intricate knowledge on the contents of the product manual. This is because the headings in the document are in many cases opaque and give insufficient information on their contents.

5.3 The usability of the product manual

In the discussions, efficiency emerged as the central usability issue in the product manual – all of the users identified the inefficiency of information searching as the primary usability challenge. Efficiency is both a factor which affects information seeking behaviour (Wilson 2006, 660) and an integral component of usability (Nielsen 1993, 25). As discussed in section 3.2, Nielsen (1993, 26) defines efficiency as the level of productivity a user can utilise a system. Wilson (2006, 660), in turn, defines the term as the time it takes for a user to find information (see section 2.3). I use a combination of these two definitions as the measure of efficiency in this discussion: efficient, or productive, use of the product manual means that users can find the information they need quickly. Whereas Nielsen (1993, 25) defines efficiency, learnability, and memorability as separate components of usability, I address learnability and memorability as components

of efficiency. Although I modify the hierarchy between the components for the purposes of this discussion, they each remain facets of usability.

In the discussions emerged several factors which affect the efficiency of the product manual, such as the poor findability and comprehensibility of information as well as information design of the document. The issues which affect the efficiency of the document are also those that affect the information seeking behaviour of the users: whenever the users regard the product manual as an inefficient information source, they opt for human sources.

5.3.1 Findability

The most prominent factor which hinders the efficiency of the product manual is the poor findability of information. The information that the product manual contains is a vast resource and, especially in the tendering process, the users feel that it is quicker to find the information elsewhere. This coincides with Wilson's (2006, 660) notion that users prefer the information seeking route they deem most efficient or effective, in this case, human sources. The users likely consider human sources more efficient based on their previous experiences with the product manual. That is, the users assume that information searching will be time-consuming and hence consult human sources. Especially in the case of a novice user, the time it takes to find information has a major effect on the information source he selects:

(11) **Osallistuja B**

Se mikä siihen niinku oikeastaan niinku vaikuttaa, vaikuttaa niin on, on aika. Se että monesti ei oo vaan yksinkertaisesti aikaa niinku syventyä tuotemanuaaliin niin pitkäksi aikaa et sä saisit sieltä itse sen vastauksen. [- -] Eli jos on joku asia mitä ei tiää ni se on vaan niinku ajan säästämiseksi nii helpompi kysyä (.) kavereilta jotka on ollut 30 vuotta noitten kans tekemisissä --

Participant B

What really affects it is time. Often there is simply no time to delve into the product manual for so long that you could find the answer yourself. [- -] So, if there is something that I do not know, to save time, it is so much easier to ask colleagues who have dealt with these for 30 years --

The user feels that attempting to find information in the product manual involves the risk of wasting time in searching information. The user also believes that the risk of the information seeking resulting in failure is high. Failure, in this case, refers to a situation where the user either is unable to find the information he needs or finds information which is unsuitable for his needs.

Although the situation described in extract (11) can appear to result from the user's level of experience, this is likely not the case. According to what the users reported, the time it takes to find information also affects the information seeking processes of experienced users. For the novice user, one factor which affects his information seeking behaviour is the risk of failure in addition to time-consumption. For experienced users, it is mainly time-consumption due to which they prefer to seek information elsewhere. Experienced users may know that the information they need is in the product manual and that they are able to find it in the document. However, the users are also aware that searching for the information in the product manual takes a considerable amount of time. Indeed, depending on the information that they need, the experienced users reported that it is easier, that is, quicker, to ask a colleague than to search for information in the product manual.

The inefficiency which results from the poor findability of information has concrete effects on the users' everyday work tasks as well as their information seeking behaviours. The poor findability of information in the product manual reflects in the users' perception towards information seeking. The majority of the users reported that they experience information seeking as a neutral aspect of their work tasks. However, several users also reported that while information seeking may feel neutral to begin with, the process becomes frustrating if the users are unable to find the information they need.

5.3.2 Information design

Another aspect which hinders the efficiency of information searching in the product manual pertains to the manner in which information is presented in the document. As mentioned earlier, the product manual contains information on product components which together comprise different product configurations. What the users regard as troublesome in the presentation of information is that

the document provides information one component at a time. The document does not present component combinations that comprise different products. Because component information is highly fragmented in the product manual, the users find it difficult to perceive the overall compositions of products.

Several users identified fragmented information as a major aspect that disrupts the efficiency of information seeking. One of the main issues is that the users must first search for information on one component and then on another related component. One user described this issue as follows:

(12) **Osallistuja G**

Välillä taas se ärsyttää etenki tuotesarja 1:n manuaalissa ku on pilkottu niin pienii osii että siinä et nää niinku, yhdellä sivulla näät niinku jossain komponentti 3:n kuvassa osanumeron ja sit katot komponentti 8:n kuvan jostain toisesta. Et siin joutuu hyppii ees taas.

Participant G

It is sometimes annoying that information in the product manual of product line 1 is divided into such small pieces that you cannot see, you have a part number in a drawing of component 3 on one page and then you have a drawing of component 8 on another page. You have to browse back and forth.

The user commented that searching information on the combination of components or the overall composition of a product requires browsing the document. This is because information in the product manual is presented in separate units. To produce an overarching view of the component combination, the user has to combine the pieces of fragmented information himself. The user regards this process as annoying, likely because it is inefficient and time-consuming due to the large size of and the amount of information in the product manual.

Fragmented information does not cause problems only for the users themselves but for other parties, as well. In extract (13), one tendering engineer describes the problem that fragmented information can cause when forwarding information:

(13) **Osallistuja C**

Meil on kokoonpanokuvat on sillee et sul on komponentti 8 ja, komponentti 8 siellä erikseen ja sit on komponentti 7 erikseen, komponentti 3,

komponentti 4 (). Että kun yrität selittää asiakkaalle et minkälainen hänen rakenteensa oikein on niin tuota niitten palasteltujen kuvien kanssa siihen menee pikkasen aikaa.

Participant C

The assembly drawings are such that you have component 8 separately and component 7 separately, component 3, component 4 (). So when you try to explain to a customer what the structure of his product is like, with the separate drawings it takes quite a bit of time.

The user commented that fragmented information causes problems especially in situations where he forwards information to customers. The user states that the users of the document are likely accustomed to managing the fragmented information because they use the document on a daily basis. Conversely, customers, for instance, who have no access to the product manual, struggle with the way the document presents information.

5.3.3 Comprehensibility

The users also experience frustration in cases where they find the information that they need but the information is difficult to understand. Difficulty understanding information pertains to the usability component of comprehensibility (see section 3.2.2). As defined by Suojanen et al. (2012, 53), comprehensibility as regards the usability of texts is related to how well a text fulfils its communicative function. Comprehensibility is a subjective component of usability as it is closely connected to the cultural and educational background of each individual user (*Ibid*). Poor comprehensibility of information affects the efficiency of information seeking because users have to spend a considerable amount of time trying to understand the information. Poor comprehensibility of information was not as common a usability issue as, for example, the poor findability of information. Comprehensibility primarily emerged in connection to unfamiliar or complex topics. One user described situations involving elusive information as follows:

(14) Osallistuja H

Työtehtävinä niin pitkään kunnes sit tulee joku ettei (naurahtaa) ettei se selviäkää se asia et tota et et eihän siin, paljon siel on semmost tietoo mikä kun vaan maltaa lukee niin ne selviää et et siin siin se on ihan työtä. Mut et

sit jos siel on jotain epäjohtonmukasuutta tai tai et joku asia ei oikee aukee. [- -] sithän se tulee taas se turhautuminen ehkä siin kohtaa et jos ei se tieto rupee aukeamaa. Mut pääsääntöisest aika neutraali.

Participant H

It is just a work task until you encounter something that (laughs) you don't understand, there is a lot of information there that, if you just read it, you understand it and in those situations it is just work. But if there are inconsistencies or something does not make sense. [- -] It becomes frustrating again if the information does not begin to make sense. But in general, it is pretty neutral.

Although the user describes the contents of the product manual as mostly understandable, she acknowledges that this is not always the case. The text in the product manual is, at times, inconsistent or difficult to understand, which produces feelings of frustration. A probable reason for the frustration is that information searching in the product manual is an integral part of the users' work. Therefore, if the users either have trouble finding information or difficulty understanding information, it disrupts their workflow.

5.3.4 The effects of the product manual's usability issues on workflow, emotions, and attitudes

Especially among the design engineers, the users feel that unsuccessful or inefficient information seeking frequently disrupts their work task. Unsuccessful information seeking refers to situations where the process results in failure: users do not find the information they need. Inefficient information seeking, on the other hand, refers to situations where the users spend a considerable amount of time seeking information. Both of these unfavourable situations have concrete effects on the users' workflow. All design engineers reported that they experience instances where they are unable to complete a task because either information seeking or searching is unsuccessful or inefficient. Occasionally, the disruptions can continue for extended periods of time, which can make it difficult for the user to return to those tasks once they acquire the information.

In addition to disruptions in workflow, the poor efficiency of the product manual affects the users on an emotional level. The design engineers reported feelings of irritation as regards inefficient information seeking. As in extract (14), users also reported that although they experience information seeking as neutral

to begin with, unsuccessful or inefficient information seeking produces negative emotions. These emotions include, for example, frustration in situations where information is difficult to find. Regardless, a recurring, unanimous opinion among the users appears to be that the difficulties in the information seeking process are a part of the job – the users seem to have accepted that information is difficult to find and that information searching is time-consuming and arduous.

Because the users have accepted inefficient information seeking as a natural part of their job, they rely heavily on their memory traces when seeking information. The majority of the users commented that experience with the product manual aids its use. As a result, several users reported that they consider possible alterations to the product manual as daunting, an attitude reflected in extract (15).

(15) **Osallistuja I**

– – ja se herättää tunteit sit jos joku onki muuttunu eri paikkaa et se ei löydykää enää rutiinil sielt mist se on ain löytyny – –

Participant I

– – and what elicits emotions is if something has been moved to a different location so that you can't find it where you routinely found it before – –

This extract suggests that the user experiences resistance to change because changes to the contents or structure of the product manual would disrupt the routine patterns via which the users search information. If the product manual were to change, information searching would become difficult because the users would need to acquire new routine search routes. Acquiring these new routes might initially require more cognitive efforts from the users, even if the changes would ultimately make information searching more efficient. Instead of hoping for changes, there appears to be a consensus among the users that if one finds information searching in the product manual difficult, the solution is to gain more experience through repetition. One experienced user commented on the matter as follows:

(16) **Osallistuja A**

Tietyst niinku, että jos sitä käyttäs paljon ni se varmaan niinku muistuu sitte mieleen et miten se on niinku rakennettu sinne (.) sinne mut kun ite ei niin

kauheesti sitä käytä että kun ne ei oo niin ne tilanteet sellasia mis tarvii, tarvii niin ei välttämättä kuitenkaa päivittäisii.

Participant A

Of course, if I used it often I would probably remember the structure, but I do not use it that often because the situations where I need it do not necessarily occur on a daily basis.

In extract (16), the user supposes that frequent use of the product manual would aid the user situations where information is difficult to find. The user feels that because he does not utilise the product manual that frequently, it is to be expected that he finds it difficult to navigate. This type of thinking suggests that the product manual is not memorable. Memorability as a component of usability entails that it is easy for users to return to a system after a period of time not using it (Nielsen 1993, 26). Based on the comment above, however, re-establishing proficiency with the document is difficult and becomes the harder the longer a user does not use it.

Extract (16) echoes the attitude that information seeking becomes easier through experience, and that this is the natural course of development in using the product manual. This attitude towards information searching emerged from the comments of all users. When discussing situations where information is difficult to find, experience and repetition emerged as considerably more frequent solutions than potential alterations to the document. Altering the document might entail, for example, reorganising information or the use of transparent, informative headings, both of which could facilitate information searching in the document. The general attitude is that the user is responsible for his or her ability to find information instead of the product manual requiring improvements in terms of usability.

In section 5.2.2, I discussed that the users regard the product manual as a reliable source of information when they wish to confirm something. However, the product manual is not always the source of confirmation that users primarily consult, even in cases where they know the manual provides the information they need. In some cases, users prefer to verify information from more experienced users, a situation that one experienced user reports he encounters frequently. Another experienced user commented on the matter:

(17) **Osallistuja H**

– – se niin kun miksi ihmiset kysyy multa tai Osallistuja I:ltä on usein se et ne ei jaksa sitä 900 sivuu ja sit ne kokee et on helpompi kysyy meiltä.

Participant H

– – the reason why people ask me or Participant I is often because they cannot bother with the 900 pages and thus find it easier to ask us.

This comment suggests that because of its considerable size, some users regard the product manual as difficult to approach. Users may consider the information seeking process to be unreliable by default, which means that they presume that they will not be able to find what they need. This attitude likely stems from previous experiences users have with the product manual where information searching has proven difficult or overly time-consuming. In section 5.2.1, I mentioned that users may harbour certain presumptions about the information presented in the product manual and therefore seek information elsewhere. Similarly, because of the breadth of the product manual, the users may have certain preconceptions about information searching. The length of the document combined with insufficient search functions, for example, may deter users.

5.3.5 Summary

In summary, the overarching usability problem of the product manual is its inefficiency in the information seeking process. There are several aspects which contribute to the poor efficiency of the document. Firstly, information in the document is frequently difficult to find. As a result, the users may spend a considerable amount of time searching information. The users may also fail to find the information they need. Secondly, the information design of the document reduces its efficient use. Information in the product manual is highly fragmented with no representation on the comprehensive product, and the users are required to compile information from separate fragments. Thirdly, some of the information in the document is difficult to comprehend, which increases the time users spend trying to understand it. Incomprehensible information can result in the user having to consult human sources in addition to the product manual.

The inefficiency of the product manual has concrete effects on the users' workflow, emotions, and attitudes. The poor findability of information can disrupt

the users' workflow and delay completing work tasks. The users reported feelings of frustration and irritation in cases where information is difficult to find or comprehend. Poor memorability, in turn, causes resistance to change among the users because changes to the document would result in the users having to relearn its contents.

5.4 Possible improvements to the usability of the product manual

As discussed in section 5.4, the key usability issue as regards the product manual is inefficiency. The factors which hinder the efficient use of the document in information seeking and searching include the poor findability and comprehensibility of information as well as the current information design. The question then is, what kind of alterations to the product manual would make the document more efficient in terms of information seeking and searching?

According to the users' experiences, the primary reason for the poor findability of information stems from the length of and the large amount of information in the product manual. As discussed in section 5.4.3, the length of the document may deter users, which is part of the reason they prefer seeking information elsewhere. Therefore, the purpose of improving the findability of information in the product manual is to make the document more approachable. The approachability of the product manual could be improved if the users could be confident that information searching is not overly time-consuming and that they are able to find the information they need.

The alterations that would facilitate finding information pertain to two distinct aspects: changes to the information searching strategies possible in the product manual and changes to the textual aspects of the document. Although the former changes might be difficult to accomplish in a strictly linear PDF document, I have included those aspects in this discussion. This is because the documentation processes in the company are currently undergoing significant changes, moving away from linear PDF documentation and towards structured documentation. Therefore, in the discussions there was no limitation as to what kinds of alterations are possible, and the users were welcome to suggest them freely without restrictions on what is feasible in the current documentation environment.

5.4.1 Additional functionalities

There were two functionalities that emerged most frequently in the discussions as regards facilitating information searching. These included the option to filter the contents of the product manual and a search function based on approximate string matching (fuzzy search). The majority of the users in the discussions considered the possibility of an enhanced filtering function in the product manual as useful. One of the tendering engineers commented on the issue as follows:

(18) **Osallistuja A**

Nii. Et niinku menis alussa niinku tiedot, oletukset napsaamaa ja sit se poistais ne. [- -] Nii 900 turhaa sivuu ja jättäs vaa. Minustahan se ois olis niinku edistystä, se kuulostas fiksulta. Siel ois vaan se (.) mikä koskee sitä rakennetta mitä sie just oot niinku käsittelemässä.

Participant A

So at the beginning you could select the default information and it would delete them. [- -] The 900 unnecessary pages and leave it at that. I think that would be an improvement, it sounds sensible. There would only remain that (.) which concerns the structure you are currently dealing with.

Extract (18) suggests that a filtering function would be especially useful because it would allow the users to filter out the contents unnecessary for the current task. In other words, the primary advantage of a filtering function would be its effect on the length of the document. This is because the users are required to browse through a considerable amount of potentially irrelevant information and may ultimately be unable to locate the relevant content in the document. Searching for information when only the relevant contents of the product manual are on display would make the information searching process more efficient in terms of time-consumption and effort.

In addition to a filtering function, another functionality which the users feel would aid information searching in the product manual is a fuzzy search function. Whereas the currently frequently utilised Ctrl-F function requires a user to know the specific term or wording of the search target, fuzzy search allows the user to word the query in a way that matches the target approximately, not exactly. When discussing the benefits of a fuzzy search function, one user stated:

(19) **Osallistuja H**

– – se että se control f ei ois sitä et sie yrität ettii sitä oikeeta sanaa millä se nyt ehkä sattuu löytymään, jos ei löydy niin sit sie kokeilet seuraavaa sanaa, niin toki se et siinä ois jotain älyä siinä hakutoiminnossa et et vaikka et minun tarvitsee tietää saako tämän tuotteen, tämän tuotekoon titaanista ja sit se pystyis tuottaa sen sielt sulle että kyllä tai ei ja veis siihen kohtaan mistä se asia selviää.

Participant H

– – the fact that using control f would not be that you try to find the right word with which you might be able to find it, if not, then you try another word, so the search function to have some intelligence so that, for example, if I need to know whether this product, this product size can be made of titanium, it would be able to produce a yes or no answer and direct you to the section where it is stated.

The user in extract (19) recognises that determining the correct search term for Ctrl-F can be time-consuming and therefore affect the efficiency of information searching. In cases where a user is uncertain of the correct search term, a fuzzy search function could help direct the user towards the information he needs, even though the search term were not entirely correct. Whereas an incorrect search term in Ctrl-F search would result in an impasse for the user in information searching, fuzzy search could allow the user to continue the process in a potential direction. A fuzzy search function therefore involves two potential benefits for the users. Firstly, the users would not be required to know the exact search term and hence would not be required to spend time determining the correct wording of the query. Secondly, as a fuzzy search function would allow less precise queries, the search might produce less results than the Ctrl-F search function. Both of these aspects could reduce the time spent searching information in the product manual.

5.4.2 Changes to textual aspects

Aside from additional functionalities, the findability of information can be improved by altering some of the textual aspects of the product manual. These changes include the transparency of headings, the standardisation of terms, and standard principles of information design. Similarly to the alterations discussed above, alterations to the textual design of the document would primarily affect the effectiveness of browsing and querying in the product manual. These alterations are such that they can be implemented in either linear or structured documentation. Ideally, these changes would be applicable to the entire

documentation within the company because that would improve the findability of information also in documents other than the product manual in question. Additionally, the uniformity of documentation could make different documents more approachable and intuitive to use.

The first alteration concerns facilitating information searching via browsing and title-based navigation: the use of informative, transparent headings. As stated by an experienced user in extract (9) and a novice user in extract (10), navigating the document based on the table of contents is difficult because the headings give little to no indication of their contents. The use of transparent headings would eliminate this requirement and therefore improve the usability of the document especially for novice users and users who utilise the document infrequently. Information seeking would then be more time-effective because the users would not have to search for information based on guessing the contents of the headings or in a trial-and-error manner.

In addition to decreasing the time it takes to find information, the use of transparent headings would make the document more intuitive to use. As noted in section 3.2, intuitiveness is not necessarily a quality directly connected to the expertise of the user, although a commonplace definition of the term might suggest so. Transparent headings can help users intuit the relevance and contents of different sections in the product manual and therefore allow them to navigate the document based on their intuition rather than their existing knowledge of the contents. This could be especially beneficial for novice users of the document and users who utilise the document infrequently and therefore have little familiarity with its contents.

Another aspect which would improve the findability of information by making the product manual more intuitive to use is the standardisation of terminology. There exists some level of inconsistency in terminology both within and across product documentation in the company, although the issue explicitly only emerged once during the discussions. Despite the infrequency of the topic in the discussions, it can contribute to why the users struggle with Ctrl-F queries, as their conception of a term may be based on the form in which it occurs in a different document. As one user commented:

(20) **Osallistuja H**

Mutta siinä on hyvä esimerkki kyl control f, kokeilet ensin termi 1:llä ja sitten kun ei (naurahtaa) löydy kirjoitat termi 2 että. Se on ihan jokusenki kerran tullu tehtyy se haku.

Participant H

But that's a good example of control f, you first try with term 1 and when you cannot (laughs) find it you type in term 2. I have done that search a good number of times.

In extract (20), *term 1* and *term 2* are near-synonyms that denote the same product component. However, instead of one term occurring across the company's documentation, the two terms occur interchangeably in different documents. Users who work with the documentation of a certain product become accustomed to the terminology used in the context of that specific product. Then, if they are required to consult the documentation of other products in their work tasks, the contradicting terms can disrupt the users' information searching in those documents. If the users are unable to find information in a document using the term with which they are familiar, the users may conclude that there is no information available on the topic in that document. As a natural consequence, they result to seeking information elsewhere.

In addition to standardising terminology, implementing standardised principles of information design to the company's documentation could facilitate information searching. When discussing the differences in information design between product documentation, one user commented:

(21) **Osallistuja H**

Mahollisimman samanlainen ku se käyttäjäkokemus ois eri tuotteitten välillä ni kylhän se helpottais sitte. Että tavallaan kun sie tiiät et miten yhtä manuaalii luetaa ni sen jälkee se ei ois niin iso kynnys hypätä kattoo seuraavan tuotteen manuaalia.

Participant H

It would be easier if the user experience was as similar as possible between different products. That way, when you know how to read one manual, the threshold to reading another manual would not be so high.

The documentation process in the company appears to lack uniform guidelines as to how documents should to be structured and how information in the

documents should be formatted. Although the manuals for different products contain similar sections and similar information, the manuals have been authored according to the preferences of each individual writer. In extract (21), the user's comment suggests that uniformity between product manuals would improve the users' sense of familiarity and therefore the intuitiveness of the documentation. The user would be able to anticipate what kind of information is presented in each section of the product manual, even if she had not used that manual before. As regards the standardisation of the product manuals of different product lines, another experienced user stated that it would also be beneficial to standardise the way information is presented:

(22) **Osallistuja I**

Niin se että toi ois tiedon tavallaa niinku esitystapa ois samanhenkinen eli toises voi olla jonkinnäkönen käyrä, toises on sitte taulukoitu tieto tai vastaavaa et se ois sit niinku tavallaa, jos sie katot tuotesarja 1:n manuaalist haet jonkuu tiedon ni saat sit niin kun vastaavanlaisesta tuotesarja 3:n manuaalist haettu niinku samalla viistii tiedon niin vois kuvitella et ois niinku hyötyä.

Participant I

The presentation of information could be similar, that is, currently one may have a curve, another may have the information in a table or something, so if you look for some specific information in the manual of product line 1 and then consult the corresponding manual of product line 3, I imagine that would be helpful if you could have the information presented in the same manner.

In extract (22), the user comments that similar information in different product manuals is occasionally presented in disparate ways, whereas it would be beneficial to have similar information presented in the same format in all documents. Although standardising the way information is presented may not directly affect the findability of information, it can make the product manual more approachable and intuitive to use. Novice users in particular might find the document easier and more intuitive to use if they could anticipate the format in which information is presented. In addition, experienced users would not have to rely on their experience if the product manuals had corresponding structure and information formatting.

The standardisation of terminology and information design would also affect the memorability and learnability of the product manual. If all documents with

similar purposes, such as all product manuals, contained similar information in similar format, users would find it easier to remember the structure and contents of the documents. This notion is again related to the increased intuitiveness and familiarity with the documentation in which standardisation would result. Increased learnability would facilitate the use of documentation with which a user has no prior experience. Increased memorability, in turn, could make it easier for the users to return to a specific document after a period of not using it.

Another aspect that the users reported hinders the efficient use of the product manual is fragmented information. The fragmented nature of information has a negative impact on the efficiency of information searching in the product manual, because forming an overall view of the product is highly time-consuming. This problem of fragmented information could, at least partly, be solved with the filtering function discussed in section 5.5.1, because the users would be able to filter out irrelevant information. Browsing through filtered contents when the users require a comprehensive view of a product configuration would likely be less arduous, albeit filtering in itself would not provide the users with information on the overall composition of a product.

Conversely, the solution the users themselves most frequently suggested for the issue of fragmented information was the option for complementary information. Complementary information here can refer either to additional information on specific aspects or components of the product or to information on the overall composition of a product configuration. The option for complementary information entails that the product manual itself would not necessarily contain the information, but the manual would contain, for example, a link to an information source outside the document.

As discussed in section 5.2.1, the design engineers appear to be more concerned with complementary information on the qualities or background information relating to the product components. For the tendering engineers, in contrast, the desire for complementary information pertains specifically to the overall compositions of products. In extract (23), a tendering engineer discusses why he feels complementary information would be useful.

(23) **Osallistuja C**

No sithän se voi olla tietyst 3D:ssä, sit sie valitset komponentti 1:n ni se laittaa ne () komponentti 2 sinne tähän. (.) Tälläsii tulee. Selvitellää et mitä pitää tehdä. Olis helppo näyttää asiakkaalle et minkälain se rakenne on mikä hänen tuotteessaan nimenomaan on et ei tarvi koostaa useemmasta kuvasta.

Participant C

It could be in 3D, you select component 1 and it places the () component 2 here. (.) This is what it looks like. Then we find out what we need to do. It would be easy to show the customer what the structure of his product is like without having to construct it from several drawings.

In this extract, the user feels that the core benefit of complementary information in the product manual would be to facilitate customers' understanding of their product configuration. The information the user forwards to the customer would, by default, be in more comprehensible format if the user did not have to compile the information from the separate fragments in the product manual. Complementary information on the compositions of products would, of course, not only aid the users when they need to forward information to customers, but it would also make information searching for their own work tasks more efficient.

In section 5.2.1 I suggested that the users typically seek complementary information from human sources in situations where the information in the product manual is insufficient for their needs. Adding the option for complementary information to the product manual could reduce the need to consult human sources for additional information. This could make information searching more efficient because the users would not be required to seek information on the same topic from several sources. Simultaneously, it could help the users form a more tangible grasp of the composition of the product or a specific part of the product. In extract (24), two design engineers discuss the possibility for complementary information.

(24) **Osallistuja E**

Tiesti ainahan se video ois semmonen niin kun selkee. Sitte jos joku linkki vaikka johonki.

Osallistuja G

Mut eihän sekää yksinään toimi sit taas.

Osallistuja E

Ei yksinään mutta siis tukena. Se tuli mieleen vaa just että voishan siinä olla jotain just QR-koodia vaikka johonki videoon.

Participant E

Of course, a video would be straightforward. And a link that takes you somewhere.

Participant G

But that will not work on its own, though.

Participant E

Not on its own but as a means of support. It just came to my mind that it could be like a QR code for a video.

In extract (24), the emphasis is on complementary information being presented in video format, not merely presenting the existing information as a video instead of text. The primary function of complementary information in this case would be to aid the users' understanding of the product by providing an alternative perspective to the matter, so to say.

5.4.3 Summary

The suggestions to improve the usability of the product manual that emerged during the discussions pertain to three aspects of the document: additional functionalities, standardisation of information design, and additional content. The additional functionalities that the users reported would make information searching more efficient include the option to filter the contents of the document and a fuzzy search function. Filtering would be beneficial especially due to the considerable length of the document, because not all the information it contains is relevant for all product configurations. A fuzzy search algorithm, in turn, would make querying more efficient, as the users would only be required to have an approximate notion of the search target. Together these two functionalities would make information searching in the product manual easier, more effective, and less time-consuming.

The alterations pertaining to the textual elements of the product manual include the standardisation of terminology and standardised practices of

information design. The standardisation of terminology means that predefined terms for certain referents were used across the entire company's documentation. Standardised terminology would reduce the users' potential confusion as regards terminology when they switch between the documents of different products. It would also make information searching more efficient because, when querying, the users would not have to spend time determining the correct search term.

Standard practices of information design mean that corresponding documents of different products had the same overall structure. Standardised information design also concerns presenting similar information in different documents in the same format. Uniform documents would be more intuitive to use, and users could anticipate what kind of information they can find in each section of the document. In practice, this can mean that if one product manual contains a certain piece of information in table format, the same information also occurred in table format in the manual of another product line.

In addition to the functionalities and modifications to the documentation processes, several users reported that they would find complementary information beneficial. Complementary information refers to information that would support and aid the understanding of the existing contents of the product manual. Complementary information could be presented in, for instance, video format, which would enhance the users' grasp of the textual or illustrated contents of the product manual. The option to view complementary information on a specific component, process, or the overall composition of the product would make information seeking in general more effective. This is because the users would not necessarily have to seek the same information from different sources.

6 RESULTS AND DISCUSSION

In this section, I summarise and discuss the results of the analysis and [consider] the results in relation to the research question proposed at the beginning of this study. The first section discusses the information needs and information seeking processes of the users. In the second section, I review the role of the product manual in information seeking and the strategies of information searching the users have for the document. The third section summarises the findings as regards the usability of the product manual.

6.1 The information needs and information seeking processes of the users

Based on the discussion in sections 5.1 and 5.2, I have illustrated the users' information seeking processes in Figure 3. The figure summarises the answer to the first research question: what kind of information needs and information seeking processes do the users have? Whereas Wilson's (2006, 659) model of information behaviour contains no consecutive step for *failure*, the model below indicates that unsuccessful information seeking is followed by the user seeking information from another source.

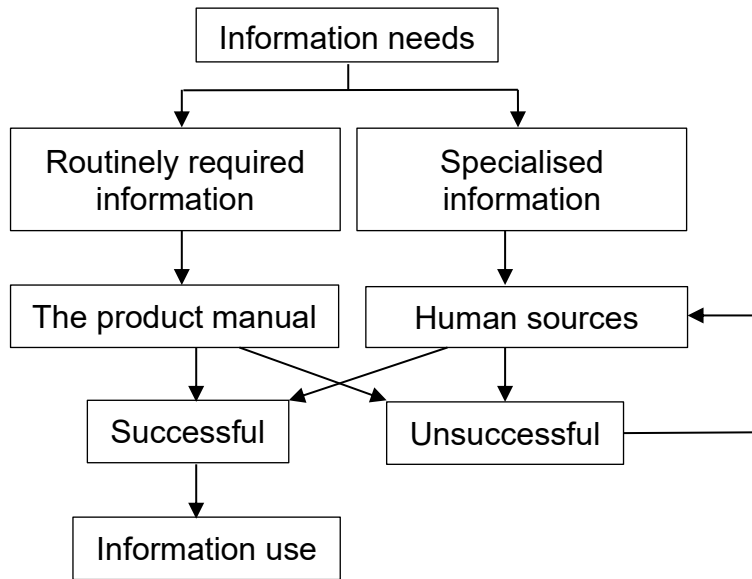


FIGURE 3. The users' information seeking processes

As discussed in the summary of information needs in section 5.1, the users have two primary categories of information needs: routinely required information and specialised information. Routinely required information is the kind of information the users routinely need to in their work tasks. In practice, this category comprises information on the components of the product. Specialised information refers to information that the users either require less frequently or have little expertise on. For the tendering engineers, specialised information is typically information on industrial processes or topics which are outside the users' personal expertise. For the design engineers, specialised information is typically information with which the users are unfamiliar because they require the information infrequently.

Information seeking from either source can be successful or unsuccessful. Successful information seeking results in information use, which occurs when a user finds information that fulfils her information need and allows her to proceed in her work task. Unsuccessful information seeking, in contrast, occurs when the user fails to find the information she needs, or finds information that is irrelevant or insufficient for her information needs. Unsuccessful information seeking most frequently results in the user reinitiating the information seeking process, but invariably selecting human sources as the potential source of information.

This issue of information needs being connected to the degree of familiarity with information agrees with the constructionist view of information needs. As

discussed in section 2.2., information needs arise from the level of knowledge an information user has on a certain topic (Naumer and Fisher 2009, 2456). From this viewpoint, the causality between a gap in knowledge and information needs is a natural, predictable phenomenon. When the users are unable to rely on their expertise or existing knowledge, they need to seek information on the topic. However, these information needs which result from lack of familiarity are not static: were a user to repeatedly seek information on a topic with which she is initially unfamiliar, she would likely eventually internalise the information and gain knowledge.

As regards information seeking, the analysis revealed that users have two distinct routes of doing so: the product manual and human sources. The choice of the information source depends on the information need a user has. In cases of routinely required information, such as component information and highly technical information, the users opt to seek information in the product manual. Because of the significant amount of, for instance, component information and the information being difficult to memorise, the users likely acknowledge that consulting the product manual is the most efficient way to acquire the information. The users also regard the product manual to be a highly reliable source of information and tend to primarily rely on it in situations where two sources contain contradictory information.

As discussed in section 5.2.1, the users seek specialised information from human sources considerably more frequently than from the product manual. This is because the product manual contains a limited amount of information on products for special applications, which means that the users are required to seek such information elsewhere. Human sources are a common source of specialised information because different people in the company have special expertise on different industrial processes. Based on the users' comments, they regard human sources as reliable and efficient sources of information in situations where they need specialised, detailed, or complementary information.

The users also reported several instances where they begin the information seeking process in the product manual and proceed to seek complementary information from human sources. Such situations can be regarded as instances of information seeking being unsuccessful, which in these cases denotes that the user manages to find information, but the information is insufficient for her needs.

A similar course of action occurs when the users are unable to find information altogether in the product manual. If a user fails to find information, the preferred consecutive step is to seek that information from a human source. The reverse course of action – the users seeking information from the product manual after failing to acquire it from human sources – occurs infrequently. Instead, failure to find information from a human source results in the user consulting another human source for the information. Therefore, regardless of the information source the user initially selects, unsuccessful information seeking results in consulting a human source.

6.2 The product manual in information seeking

This section answers the second research question based on the discussion in section 5.2.2: how do the users utilise the product manual in information seeking? In essence, the users typically seek data-related information in the product manual and knowledge from human sources. The product manual is a highly referential document in nature – its purpose is to provide information largely in data format. The analysis suggests that the document does not provide in-depth knowledge on topics, but users are expected to have the theoretical or educational background which helps them understand and contextualise the information on their own. Therefore, in cases where the users require knowledge they do not possess, the product manual is simply not meant to provide such information. In other words, the intended use of the product manual is data searching; for additional or detailed information, the users are expected to refer to other, unspecified sources. The simplest way to acquire information on specialised topics, for instance, is to consult human sources because they may either know the answer or be able to direct the user to another person who knows the answer.

Because the product manual is intended as a referential document, it does not provide the users with, for example, background information on the topics. This ties in with the users' comments about the product manual occasionally containing information that is insufficient for the users' needs. Based on the users' comments, both tendering and design engineers routinely encounter situations where they require specialised or detailed information and are required to consult

human sources for it. Therefore, I can conclude that, despite the product manual’s prominent role in information seeking, the document alone is not a sufficient source of information for the users. Especially for novice users who might not only struggle with the unfamiliarity of the product but also with finding information in the product manual, the document in its current state is not a well-suited information source. On the other hand, it is clear that the product manual is not intended to be used as the sole information source, despite its importance and reliability in the product configuration and design processes.

As discussed in section 5.2.2, in cases where the users select the product manual as the preferred source of information, they have specific strategies they employ to search information in the document. Table 4 summarises these information searching strategies.

TABLE 4. The strategies of information searching in the linear product manual

Strategy of information searching	Frequency	Advantages	Limitations
Ctrl-F	Seven out of eight users	Quick to use	Requires a specific search term
		Produces results efficiently	High number of search results
Title-based navigation	Five out of eight users	Quick to use if the user has sufficient experience with the product manual	Opaque headings: frequently a trial-and-error process
			Requires knowledge of the contents of the product manual

As the table shows, the users have two primary strategies they employ when they search for information in the product manual: querying with Ctrl-F and browsing via title-based navigation. The more frequently employed strategy is Ctrl-F querying, which is reportedly utilised by seven out of the eight users in the discussions. Title-based navigation, conversely, explicitly occurred in the comments of five of the eight users.

The users appear to prefer the Ctrl-F function in information seeking because it is quick to use and produces results efficiently. These two factors make Ctrl-F an effective strategy of information searching especially in terms of time-consumption. However, the Ctrl-F function requires the user to know the specific search term or wording of the information he attempts to find. In cases where the user is uncertain of the correct search term, employing this strategy may in fact become overly time-consuming. An additional disadvantage with using Ctrl-F is that, due to the large size of the product manual, the queries can produce a significant number of search results. The user must then invest time in browsing through the search results until he finds the information he needs.

Similarly to Ctrl-F, the users regard title-based navigation as a useful information searching strategy because it can be quick to use, provided the user has sufficient knowledge as to the product manual's contents. Because title-based navigation is a search strategy based on using the headings in the product manual, the users must be able to anticipate what kind of information is located under each heading. However, according to the comments of some users, the headings tend to be opaque and give little indication as to the actual contents of the sections. This means that in title-based navigation, users must frequently rely on their experience with and ability to remember the contents of the product manual.

The users' search behaviours reflect some of the behaviours associated with online reading: scanning, speed reading, and non-linear reading (Liu 2005; Herath 2010). The reasons for these similarities also concur with those with online reading: because of the large amount of information in the document, the users' typical information searching strategies include browsing and scanning the material. Indeed, Klusewitz and Lorch (2000, 667) note that the purpose of information search strategies is to help users efficiently locate relevant information efficiently from a large amount of content. Browsing and scanning – strategies of non-linear reading – allow the users to skip over irrelevant sections in the document, which can make reading the product manual more time-efficient.

6.3 The usability of the product manual

This section discusses the third research question: how do the users perceive the product manual in terms of its usability? As section 5.3 suggested, the overarching usability issue related to the product manual is the document's poor efficiency in information seeking. During the discussions, three key aspects emerged which negatively influence the efficiency of information seeking in the document: findability, current information design, and comprehensibility. Table 5 summarises these usability issues as well as potential measures to improve these aspects.

TABLE 5. The usability issues of and improvements for the linear product manual

Usability issue	Possible improvements
Findability	Filtering function
	Fuzzy search function
	Transparent headings
Information design	Standardisation of terminology
	Standardised principles of information design
Comprehensibility	The option for complementary information

As discussed in the analysis, the primary concrete effect of the inefficiency of the product manual is related to time-consumption. In the users' experience, searching for information in the product manual consumes a considerable amount of time, which prompts them to opt for human sources instead. Indeed, the usability issues presented in the table above disrupt the efficiency of the product manual because they increase the time required to find information.

As several of the users' comments suggested, the poor findability of information primarily results from the length of the document. According to the users' comments, the findability of information could be improved with additional functionalities, such as a filtering function and a fuzzy search function. The option to filter the contents of the product manual would reduce the amount of content a user has to browse through when using the document. In addition, filtering could

provide the users with the option to filter out content that is irrelevant to her current need. A fuzzy search function, in turn, would allow the users to make queries in the document more effectively, as the users would not be required to know a specific search term in order to find the search target. This would reduce the time the users spend browsing through the search results, making information searching more efficient.

Another aspect which reduces findability are the opaque headings in the product manual. As the users commented, title-based navigation in the document is difficult because the headings in the product manual give poor indication of their contents. As a result, browsing the document according to the headings is typically a trial-and-error process. The opaque headings cause problems especially for the novice user because, due to his lack of experience with the product manual, he cannot rely on his ability to remember the contents of each heading.

From the users' comments, it is uncertain whether the opaqueness of the headings results from the fact that they are functional instead of topical headings. The former refer to headings that typically occur in academic texts, such as *Introduction* or *Method* whose primary purpose is to provide information on the function of the section instead of its contents (Chen et al. 2023, 134). Topical headings, conversely, offer summarised information on the contents of the section (*Ibid.*). Because topical headings provide the user with an immediate overview of the contents of a specific section, such headings can support efficient skimming of the text and predict the location of the target information (Klusewitz and Lorch 2000, 675).

There appears to be little research on the relationship between headings and information searching in the context of user instructions, whereas the topic has been discussed in the field of cognitive and educational psychology. Klusewitz and Lorch's (2000, 671) research revealed that the effect of headings on information searching depend on the level of exposure a reader has previously had with the text in question. The results indicate that the more familiar a reader is with the text, the more likely she is to be able to rely on headings when searching for information (*Ibid.*). This result agrees with the comments of the product manual users who rely heavily on their familiarity with the document in title-based navigation. However, I presume headings only support information

searching in cases where the headings are appropriate to the text in question, that is, topical headings in the case in user instructions. Whereas functional headings can aid information searching in academic texts for readers who are familiar with academic conventions, such headings are not appropriate in user instructions.

Based on the analysis, the users appear to have accepted the poor findability of information in the product manual and regard the difficult information searching process as a natural part of their job. In the users' perspective, if they struggle to find information, it simply means that they do not have sufficient experience with the product manual. However, formulating the headings in the document to be more transparent would increase the findability of information and reduce the requirement of experience to successfully navigate the document.

As regards information design, the company currently appears to lack standardised terminology and standardised principles of information design in the documentation process. This means that there are inconsistencies in the terms used across the documentation and in the manner in which information is presented in different documents. As a result, the documentation has low intuitiveness, as familiarity with one document does not denote familiarity with a similar document for another product. With standardised design principles, similar information in different documents would be presented in a similar manner, which would improve the intuitiveness and therefore usability of the documentation.

In addition to standardised information design, standardised terminology would improve the efficiency of the product manual. Inconsistent use of terminology can make information searching more time-consuming: if a user becomes familiar with the terms used in one document, the transition to using another document which contains different terms for the same concept complicates the information searching process. This situation is especially prominent if the selected strategy for information searching is querying with the Ctrl-F function because then the selection of the correct search term is crucial for a successful search. The use of standardised terminology across the company's documentation would reduce the time users spend determining correct search terms and also increase the intuitiveness between documents.

The final aspect which reduces the efficiency of the product manual is the comprehensibility of information. The users reported that in some cases, the

product manual contains information that is difficult to understand or insufficient to the users' needs. In such cases, the users first search the topic in the product manual and consecutively result to requesting additional or complementary information from a human source. To make the information seeking process more efficient, the product manual could, especially in cases of complex information, contain the option for complementary information which would support and aid the users' understanding of the topic at hand. Complementary information could be presented in, for example, video or 3D format, so that the users would not have to rely solely on the manner in which information is presented in the product manual.

The usability issues associated with the product manual have concrete effects on the users' emotions, behaviour, and workflow. Previous research has shown that negative emotions can significantly affect information seeking processes in several ways, including terminating and avoiding the process altogether (Savolainen 2014, 12). The findings in this thesis concur with those of Savolainen: feelings of frustration or irritation or the anticipation of such emotions can result in the user either terminating or avoiding information seeking in the product manual. The users experience negative emotions especially when information is difficult to find or comprehend. If the users routinely have negative experiences with the product manual, over time these feelings can form into negative preconceptions about the document. Negative preconceptions can, in turn, result in the user directly selecting another information source in future information seeking events. Conversely, the user can disregard the negative feelings that insufficient information searching in the product manual elicits and accept difficult information seeking as part of their job.

The users may experience reluctance to use or continue to use the document because information is difficult to find. Additionally, the users appear to have accepted difficult information seeking as part of their work – a hindrance that comes with the job. Both of these attitudes suggest that the product manual as an information system is in need of revision and modernisation. Instead of the users adapting their behaviour and expectations to the current demands of the product manual, adapting the document in a more user-friendly direction could increase user-satisfaction. Increased user-satisfaction would, in turn, reduce the negative experiences associated with information seeking in the product manual.

7 CONCLUSION

The aims of this research were to describe the information seeking processes of the users of a heavy machinery product manual and to evaluate the usability of the product manual based on the users' reported experiences with the document. I conducted this study for a heavy industry company which operates globally in the industrial engineering and manufacturing industry. The method I employed in this study was a focus group discussion where the participants represented the actual users of the product manual.

Based on the results, the key usability issue associated with the product manual is inefficiency. There are several aspects which contribute to the inefficiency of the document in information seeking, such as poor findability of information, the current information design, and poor comprehensibility of information. These factors have concrete impacts on both the users' workflow and the way they regard the information seeking process. Implementing the alterations discussed in the analysis could make the product manual more usable and intuitive, and the information seeking process more approachable for the users. The findings of this study can also help the company's documentation processes to adopt a more user-centred approach.

As this study only included two user groups, tendering engineers and design engineers, it might be beneficial for the company to conduct further research with users from other user groups, as well. For example, a user group that was excluded from this research consists of service engineers who also utilise the product manual in their work tasks. Moreover, because there is little research on the relationship between information behaviour and the usability of technical documentation, there are ample opportunities for future research on the matter. For instance, it could be examined whether time-efficiency of information searching emerges as the primary usability attribute also in the case of more task-oriented user documentation than the referential product manual in this study.

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